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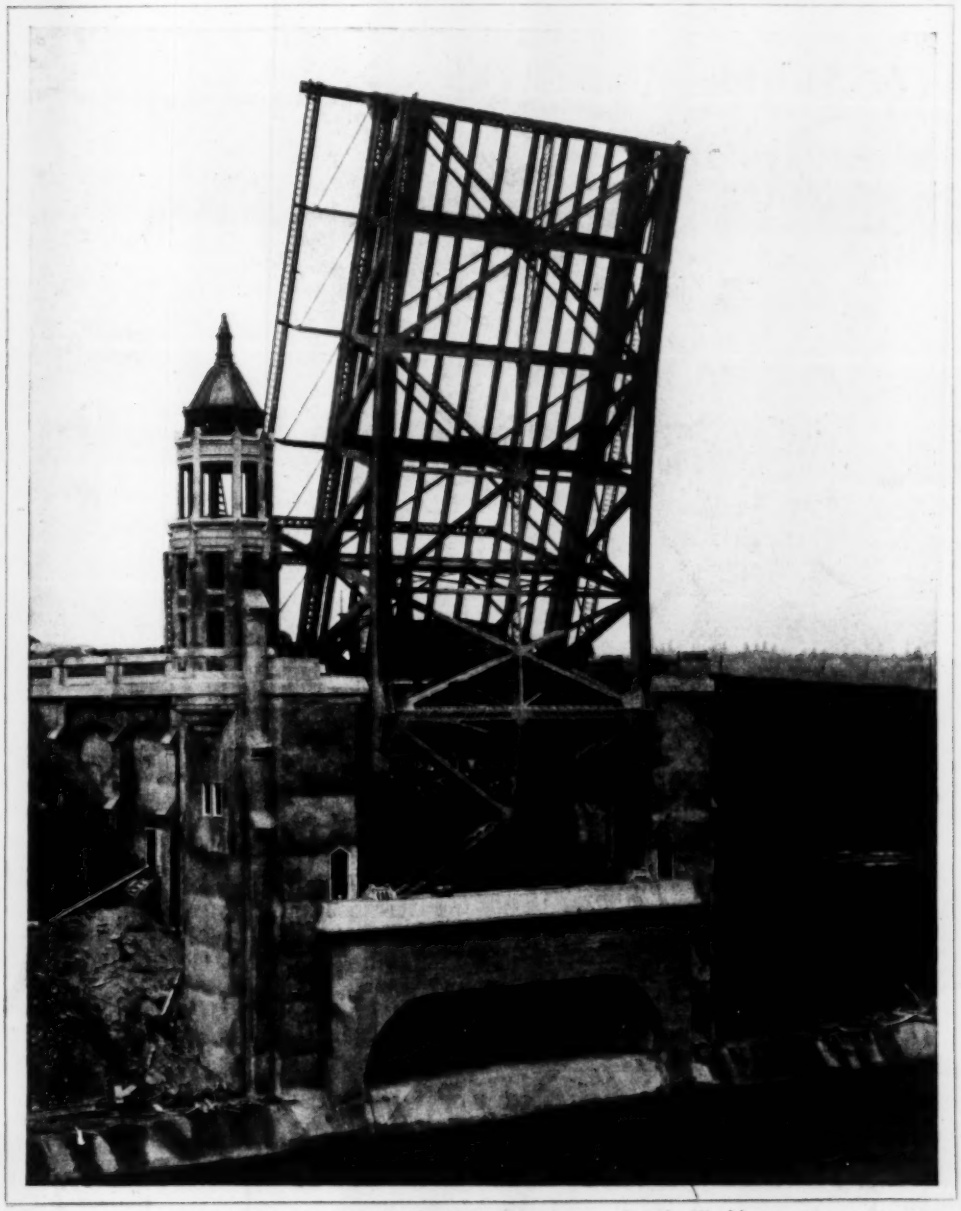
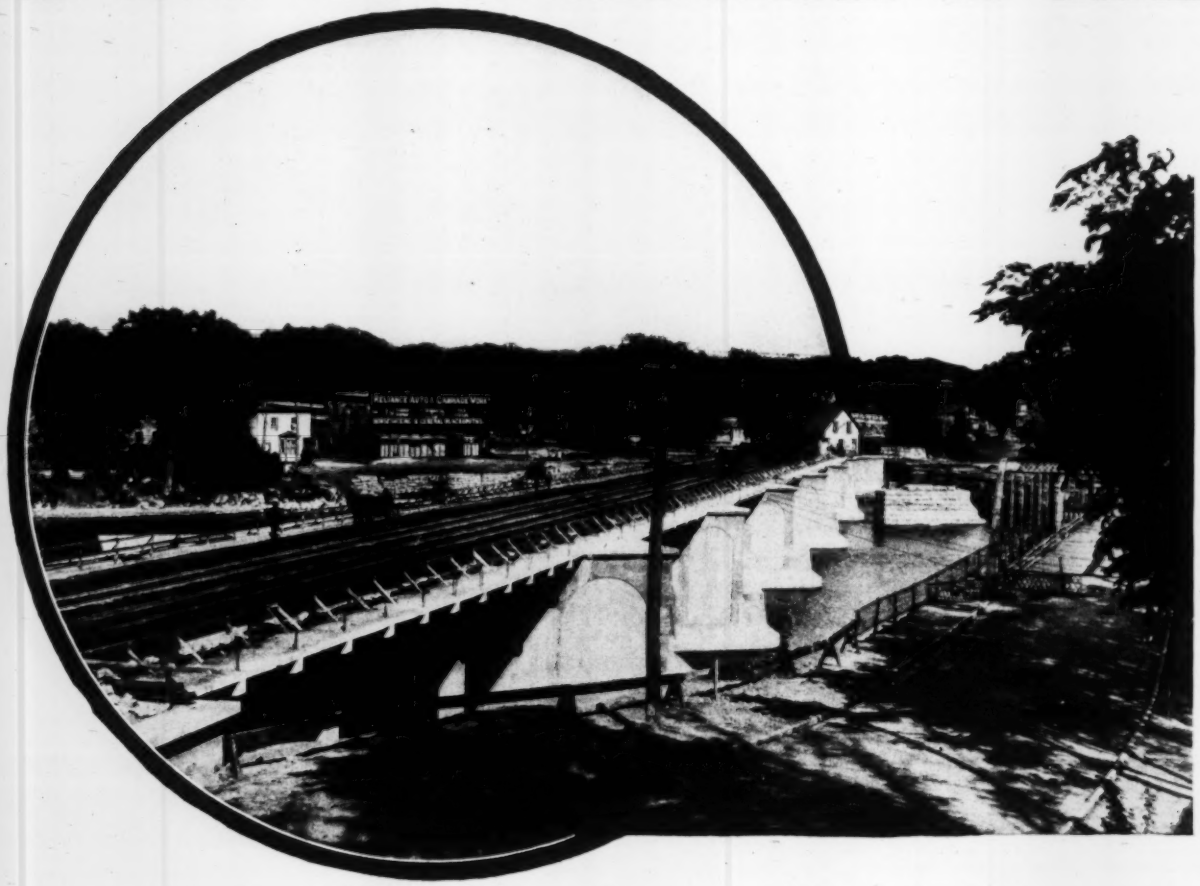


Lake Washington Canal Bridge, Montlake Avenue, Seattle, Washington

Double-Leaf Bascule Bridge at Seattle—Water Power Investigations by Geological Survey
Pavement Salvaged by Widening and Resurfacing—Reports on Utilization of Sewage Sludge
Third Article on Soil Mechanics: Determinations of Permeability of Clay

KREOLITE



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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

FRANK C. WIGHT
Editor

Volume 95 NEW YORK, NOVEMBER 19, 1925 Number 21

Light the Highways?

NO GREATER impediment to safe automobile driving exists today than the blinding headlight. Its menace is increasing rather than decreasing. Not only do the lights used seem to be growing in intensity, despite laws to the contrary, but the average driver is becoming less and less disposed to dim his lights for the approaching car. And finally there seems to be no effort whatsoever being made to enforce such laws as there are against the offensive light. The result is that motoring at night now consists in finding one's way through successive blind spots ahead caused by the intense brilliancy of approaching lights. No driver knows what may be in the hundred feet or so ahead of him, or what there is approaching him there from his right, or even how near he may be to the more or less dangerous road shoulder on his right. The automobile manufacturers have so far quite failed in their solution of the headlight peril. May it not be up to the road maintenance man? Certainly, if safety of driving and physical reaction on the driver are of any consequence it will pay to spend some money on highway illumination and then suppress the super-headlight by punitive law.

New England Looks Ahead

REGIONAL problems, not delimited by state or city lines, continue to grow in importance. The latest instance is the New England conference held last week at Worcester where agricultural, commercial and industrial representatives of the six Northeastern states got together to consider ways and means whereby the economic prestige of this oldest section of the country may be restored. One meeting cannot produce a sovereign remedy, of course, but it was enough to show that the difficulties of New England are not political, nor controllable by the individual action of any one of the states. The whole region north of Long Island Sound and east of the Hudson is an economic entity regardless of state lines, and its industrial future is tied up to the readiness with which it can consider the identity of its interest. No small part of this future, as Owen Young pointed out to the conference, depends upon an integration of the power sources throughout the region, which presupposes a survey of the water power, a definite plan for the correlation of all the water powers and the proper steam powers and a workable and fair unit control of this aggregate. How this is to be worked out by six separate states, so that each is fairly treated and so the controlling element is not given undue power is the major problem of the region, but the first step toward the solution is a recognition of community of interest. The Pennsylvania-New Jersey bridge squabble, the Colorado compact deadlock and the New York-New Jersey Port Authority insufficiency to date, all tend to discourage further regional functioning. Can New England get together to better purpose to serve an obvious economic need?

Industry's Obligation

OPPORTUNITY creates obligation. When an industry, or a trade or craft, becomes organized there is created an opportunity for clarifying and recording the best practice of that industry, and the further opportunity of progressing from the established art to an improved art by study and experiment. The industry itself, as well as the world of users and clients, profit from such work. It is a satisfaction to learn from the discussions of the steel fabricators at their White Sulphur Springs convention last week that they have become fully conscious of these obligations and are taking a keen interest in improvement of practice through research. Especially interesting is this development because the steel industry as a whole, whether on the furnace and mill side or on the fabricating side, has not in the past been a strong exponent of research and experiment, but has been of conservative cast, leaning to the maintenance of established practice except so far as increase of capacity was concerned. That the structural fabricating branch of the industry takes a more progressive attitude may be due to competitive pressure, the development of concrete construction and progress in the application of welding. Whatever its cause, however, study and research in the fabricating art will result in increased efficiency, and will place greater resources at the command of the constructing engineer.

Material and Process

RAW materials and production processes are the first and in the long run the main objectives of research by any industry. Study and development of fields of use may also become important, temporarily even controlling, but this is so much the business of the user that industry's participation in it is apt to be promotion rather than research. Materials and processes are the special concern of the producing industry, and unless both receive fullest study the industry cannot attain to its highest productive efficiency. The research work of the structural fabricators will for the present not deal with material but only with fabricating processes, it appears. Study of fabricating processes is highly important; there are many questions here in which manufacturer, engineer, and purchaser are equally interested because of their bearing on quality and economy. It is probable that many shop processes have not been carried out well enough, or not with uniform excellence, and that the quality of the product has suffered accordingly. Other processes probably have been carried on with needless labor and attempted refinement, due to lack of sufficiently precise knowledge of performance of

the product. Study of processes is the first work to claim attention in the structural fabricating field. Later, it is to be hoped, the industry's raw material will also be taken up for study. Grades and qualities of structural steel are coming to be a matter of decided interest, both from a domestic viewpoint and from the viewpoint of international trade. Within the last year or two there has been some tendency on the part of users to raise doubts concerning the uniformity and excellence of structural steel. Hitherto the users of structural steel have addressed themselves largely to the furnace and mill people in endeavoring to dispose of their doubts. They may logically address themselves to the fabricator, for his obligations cover his product as a whole—steel fully as much as quality of fabrication.

Road Construction Records

RECORD breaking road construction mileages are not so commonly told of as they were a few years ago. We take even the vast sum of our total road building operations a little perfunctorily. Individual accomplishments of magnitude are too common to be startling. Yet there is value in rehearsing the records occasionally. At the end of this year there will be half a million miles of surfaced highways in the United States. This is the latest estimate of the Bureau of Public Roads. The permanent grade, ready for surfacing, has been completed on an additional quarter of a million miles. Road surfacing is now proceeding at the rate of 30,000 miles a year. These figures include all roads, not merely those that receive federal aid. They are stupendous figures by any manner of counting. The records of individual states are equally amazing. Pennsylvania this year has added a thousand miles of paved roads to its state system. It now has 5,700 miles of such roads. Illinois built in 1923, 1,028 miles, in 1924, 1,200 miles and in 1925, 870 miles of concrete roads, and about 100 miles of other surfacing, and no county road work is counted. Broken down into its elements of materials, labor, equipment, engineering direction and contracting management, a thousand-mile annual paved road program presents an industrial development which is remarkable even among modern great creations of business. In this aspect record mileages of road construction are still significant and deserve being announced.

Traffic Improvement in Chicago's City Plan

CITY planning is sometimes charged with being impractical; a pretty picture that is never realized. Latterly this is far from true especially in the more utilitarian applications which eschew the so-called artistic and ornamental and plan the future city for a greater convenience and comfort. These dreams are coming true in a number of our cities, and nowhere with more benefit to the citizens than in Chicago. Years ago Daniel H. Burnham planned a greater and better Chicago; the City Plan Commission for more than ten years has been moving toward the city he saw in his mind's eye. The practicable and the workable were as much of Burnham's plan as the beautiful and this practicality is being developed better today in the relief of the traffic congestion in the downtown "Loop" than in any other feature of the plan.

The Loop is a little area of one-quarter square mile with an intensive development of high buildings second only to New York City. Here every working day come 15,000 street cars, 75,000 vehicles, more than a million pedestrians, all trying to jam their way through streets laid out for horse-drawn vehicles. Yet the Loop is but one-half built up, says the commission, and already $60,000,000 is the annual economic loss from traffic congestion.

The authors of the Plan of Chicago found that relief from traffic congestion might be obtained in by-passing through-bound vehicles around the center of the greatest congestion. They found that one out of six vehicles were bound to or from the produce market on South Water St., and that the non-stopping through-bound vehicles accounted for 25 per cent additional of the total Loop traffic, therefore a 41 per cent reduction in Loop congestion would take place on the removal of these two classes of vehicles. A quadrangle of wide streets was therefore devised around the Loop.

A double-deck street 110-ft. wide and costing $20,000,000 forms the northern boundary at South Water St., and this development means the removal of the market to more commodious quarters outside the Loop. Canal St., the west boundary, widened at the expense of the railroad companies for a mile, is about to be opened. Adequate connections with South Water St. are made by four bridges over the Chicago River. Widened Canal St. is one of sixteen improvements in the west side terminal agreement, being made or to be made for the city at railroad expense.

Michigan Ave., the eastern boundary, was widened in 1910 to 130 ft. from Roosevelt Road to Randolph St. as the first work constructed in accordance with the Chicago Plan. Now the 130-ft. width or wider extends north a mile to Chicago Ave. The Michigan Ave. two-level bridge with approaches a half-mile long cares for uninterrupted light traffic north and south on the upper level and heavy commercial vehicles and crossing traffic below. When proposed in 1911, 9,725 vehicles crossed the river. Now 73,000, seven times as many, are accommodated. The improvement cost $16,000,000 but raised property values $100,000,000, the adjusted taxes on which should produce for the city one-quarter of the total cost annually. In fact every Chicago Plan improvement has shown proportionate results.

The southern quadrangle boundary, Roosevelt Road, widened from 66 to 108 ft. and built as a viaduct over the network of railroads in the terminal area for a distance of 2 miles, is also nearing completion. It only awaits construction of a bridge over the straightened channel of the Chicago River to be complete. River straightening seems every day nearer accomplishment but so many railroads are involved, some of which must buy and others sell land, that negotiations necessarily cannot be rushed.

For the layman, the Chicago Plan means the wonderful Lake Front development with its 26-mile water-edge boulevard drive from the southern city limits at the Indiana line through Evanston to Wilmette, and lake reclamation for park and recreation purposes. This gets the principal purple ink splashes from the draftsmen, but Chicago's evolving plan is also giving real aid commercially to the strangling congestion problems. The lesson is clear; it is only by major engineering operations that we can hope to cure the traffic disease.

Who Should Survey Our Water Resources?

CO-ORDINATION of federal departmental activities is not the simple thing it might appear. Maybe Napoleon could have brought it about, but there is no omniscience and omnipotence in Washington which can both see the right and enforce it. Interdepartmental jealousies exist; established precedents are almost insurmountable; each functionary craves the power and authority which is the only award a miserly government bestows on its expert servants. Consequently in any attempt at co-ordination politics and personalities are apt to outweigh propriety.

Nowhere is this better shown than in the struggle going on today for the control of the survey of the water resources of the country. Such a survey is so necessary that it needs no violent proponents. Certainly, no engineering audience has to be convinced that it should be made. Who should make it is another thing, and today in Washington we find two groups lined up one against the other in the effort to get congressional appropriation and authority for the control of such survey. On the one side are the Federal Power Commission and the Corps of Engineers working together; on the other side the Geological Survey through its Water Resources Branch. The Geological Survey activities consist in the prospective presentation of a bill both in the Senate and the House which will authorize the director of the Survey to make, within a period of 20 years, an inventory of the water resources of the United States including data adequate for use in making a comprehensive plan for developing both surface and ground waters for domestic and industrial supplies, irrigation, navigation, power and other uses for the conservation and control of flood waters, for which purpose there is to be appropriated $500,000 a year for 20 years. This proposed bill has been approved by Engineering Council and by the Board of Direction of the American Society of Civil Engineers. It will go into Congress with the backing of some of the most influential engineers of the country. It is opposed by the Federal Power Commission and by the Corps of Engineers. The proposal of these allies is that, under a provision of the last Rivers and Harbors Act ordering the Secretary of War and the Federal Power Commission to estimate the cost of surveys preliminary to a comprehensive plan of river development, the coming Congress appropriate the money which will permit these two agencies to proceed with just such an investigation as the Geological Survey proposes.

The claim of the Geological Survey rests on the work that it has already done, as outlined by Mr. Jones in the article on p. 830 of this issue. The other side, for its part, argues that the Federal Power Commission is by statute required to study the water power resources of the country and the Corps of Engineers is entrusted with the navigation and, to some extent, flood control requirements, so that the Geological Survey by studying all of the varied uses of water is usurping the statutory functions of the other two branches of the government.

The arguments, it will be seen, come down to the usual basis of argument as to allocation of functions in the Washington departments—that is, the rights and dignities of the bureau rather than how best the people can be served. If this latter commanding interest is considered, however, the Geological Survey, even granting the selfishness of its desires, would appear to have the better claim to the assignment to survey the water resources of the country.

What is needed for proper future development of these resources is knowledge of physical facts, unrelated for the time to the use to which the facts are to be put. Essential engineering data regarding our water courses are most incomplete. Without those data no competent plan can be made for the development of the streams, whether that development be for power, irrigation, navigation, domestic supply or flood control. Further than that these data are not of instant observation. The behavior of a river is a matter of long study and record; the longer it is the more reliable are the deductions. It is not possible to foretell to just what use the data can be put at that future time when their collection has been sufficient to warrant a conclusion as to the rule which governs the flow and the regimen of the stream. It follows then that the study of the stream should be made independent of the possible need of the data, and by an agency which is concerned solely with the scientific record of fact. At that time when some use is to be made of this record the agency contemplating such use can then proceed from the general recorded bases to the specific data required for the specific purpose.

It follows, too, that the investigating agency must not be too detailed in the things that it studies and reports on, for that would require that it be equipped with all the expert knowledge and personnel that are required by the specific operating agencies—which would be an unnecessary and complicated duplication in government, the very thing that any reform of the departments is designed to avoid.

The Water Resources Branch of the Geological Survey, by its history and its practice, is admirably fitted for this broad scientific work. It may be, as its opponents sometimes charge, that it has assumed unwarranted expert knowledge in the constructive fields of irrigation and water power. If so, it must, if entrusted with more funds for these surveys, be careful to stay close to its important function of reporting only basic data. It is possible, too, that it has not in the past co-operated too freely with the other branches of the government which need the data it collects. If it has, that is a reprehensible error into which it has been led by the struggle for self-aggrandizement that seems to mark all Washington inter-bureau matters. It would do well to guard carefully in the future against such a tendency.

But the Water Resources Branch is an engineering organization trained in water surveys, with an experienced personnel and a mass of records. It is the body to undertake the water resources survey for the country, and not the Federal Power Commission which is an anomalous tri-headed administrative board not fitted by its make-up or its intent for primary engineering investigations nor the Corps of Engineers, which is a limited engineering organization primarily devoted to construction and maintenance. The Commission and the Corps, besides, are concerned each with single phases of river use, the basic data concerning which are only a part of the whole data that should be made available. That data can best be collected by an independent engineering body which has no concern with the construction or operation that utilizes a part of the general information acquired.

Double-Leaf Bascule Bridge Over Canal at Seattle

New Form of Trunnion Support—Bridge Designed for 12-Year-Old Foundations—Anchored Against Sliding—Novel Center Lock

SEATTLE has built a number of movable bridges over the navigable waterways within the city, and when the time came to build the bascule just completed across Lake Washington canal at Montlake Avenue the city's bridge department was prepared to meet the unusual requirements of the location. Foundations for this crossing were put in some 12 years ago when the canal was built, although at that time no detailed plans for the bridge had been prepared. Moreover, it later developed that the ground conditions at this point made special anchorages desirable. Beginning with unusual features in the foundations the department developed its own design for the entire structure, including a new arrangement for supporting trunnion bearings.

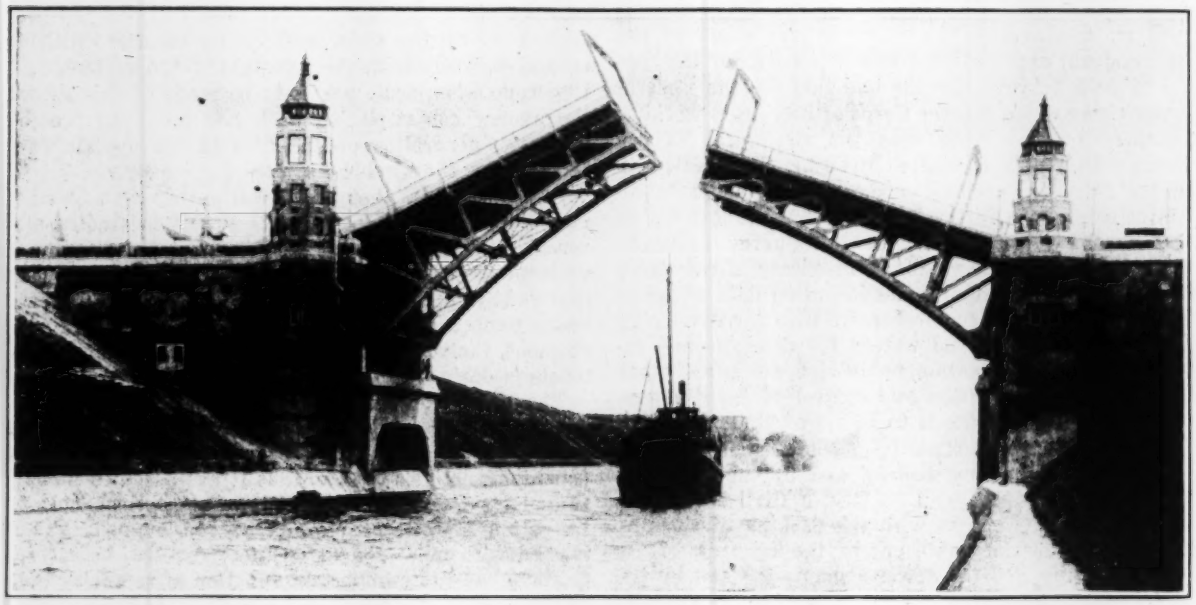


FIG. 1—LAKE WASHINGTON CANAL BRIDGE AT MONTLAKE AVE., SEATTLE

The structure has a span of 182 ft. between centers of rotation of the two leaves, and a roadway width of 40 ft. between curbs. Two street-car tracks are laid on the bridge. The design loading consists of a 40-ton street railway car on each track and one 20-ton truck on each side of the tracks, plus a distributed load of 100 lb. per sq.ft. on the remaining area. The floor system consists of creosoted timbers and planking with wood-block pavement.

The pier foundations had been built so close to the edge of the canal that in order not to impair the canal width a very deep narrow girder had to be designed to carry the forward bearing of the moving leaf. The main piers and the support for the approaches are located on the steep slopes of a cut which is about 100 ft. high from the bottom of the canal to the top of the slope. While the material in this cut in the main is stable, being chiefly a very hard packed mixture of clay and gravel, there is a layer of fine sand mixed with some gravel below the water level of the canal, and test borings indicated that this material had a tendency to run when excavation in it was attempted.

It was therefore considered inadvisable to reduce in any manner the stability of the slope on which the approaches are constructed and the load of the structure was carried independently of the surface of the slope. This was accomplished by driving seventy 14-in. and 16-in. steel pipes down to the desired elevation, excavating the material inside them, driving wooden piles by means of followers through the pipes to the depth necessary to develop the required bearing capacity, and filling the pipes with concrete.

The shafts of the trunnion-bearing piers are of rather slender dimensions—about 11 x 14 ft. in plan—and to avoid any danger of an embankment slip and to make sure of avoiding any change in the span length between trunnions it was considered advisable to brace the piers at the level where they intersect the slope of the cut. This was accomplished by a concrete strut containing 32 sq.in. of tension steel and extending to a concrete anchor 134 ft. back from the edge of the canal. This strut is designed for either tension or compression. Besides acting as anchor it helps to maintain an even pressure on the foundation during operation of the bascule leaves and under live-load.

No particularly new features are involved in the bascule span except the trunnions. By supporting the trunnions on a cantilever projection or bracket extending out from the side of the pier, a feature clearly shown in the accompanying illustration, the necessity for a cross-girder was done away with. This has the great advantage that all the space between the trunnion brackets is available for moving parts of bridge or counterweight without the necessity of framing around

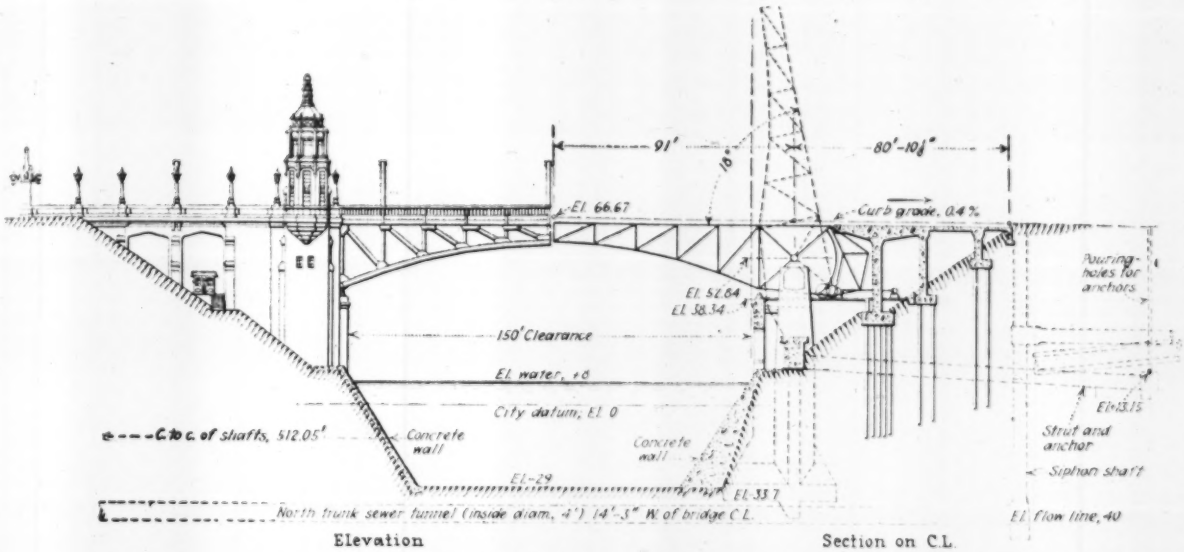


FIG. 2—GENERAL ARRANGEMENT OF MONTLAKE AVE. BRIDGE

a cross-girder as was required on earlier bridges across this canal. The moment caused by the eccentric trunnion load on the pier is taken care of by proper reinforcement of the pier shafts and of the transverse girder connecting the two piers at a level below that required for clearance of moving parts.

Aside from the use of solid, well-braced sections and substantial details in the bascule spans, there are two points of interest in the framing: the bracing around the trunnions, which is arranged in separate panels below and above the trunnions, and the provision for taking the weight of the floor when the bridge is in

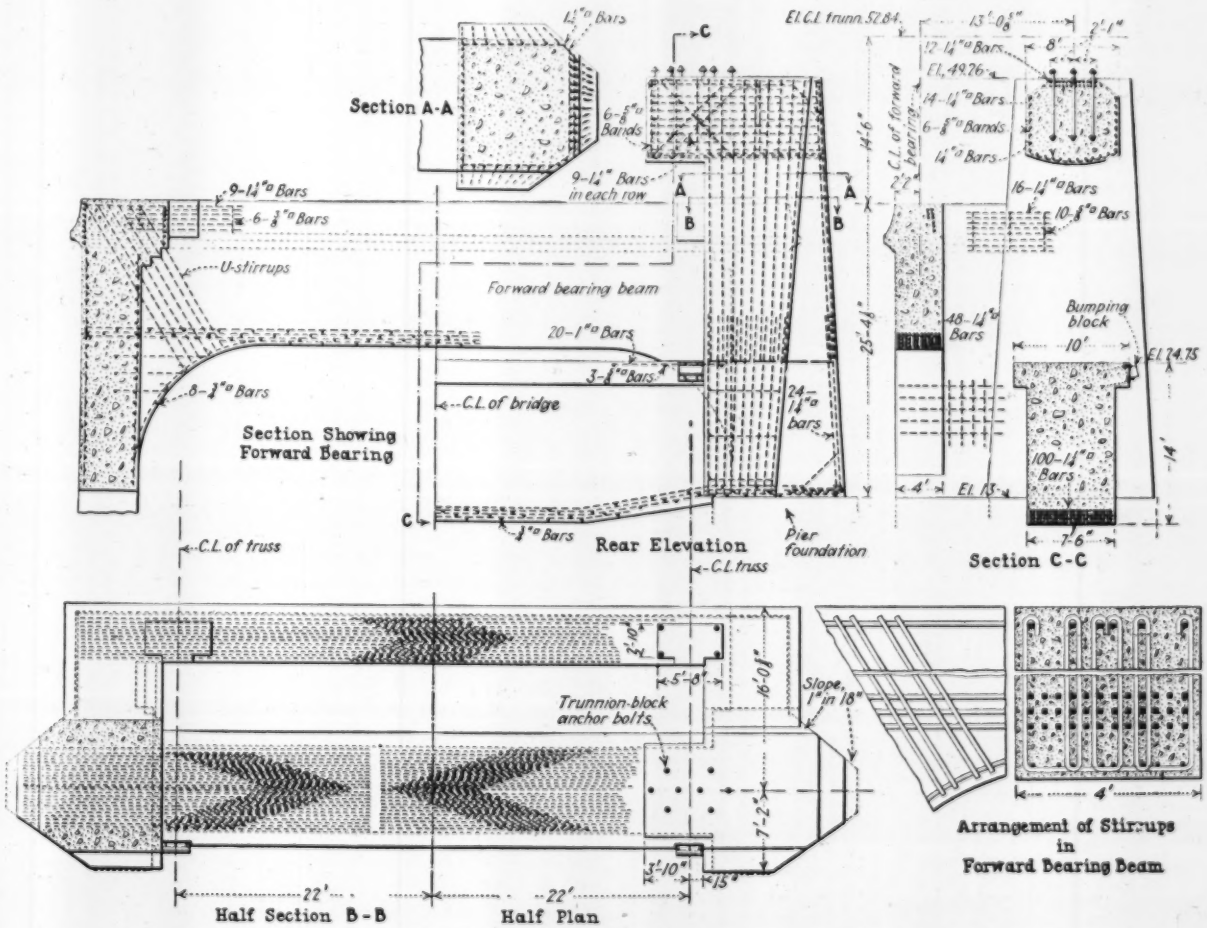
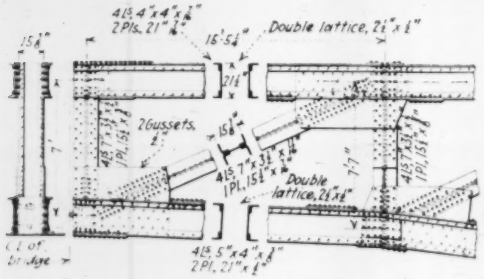
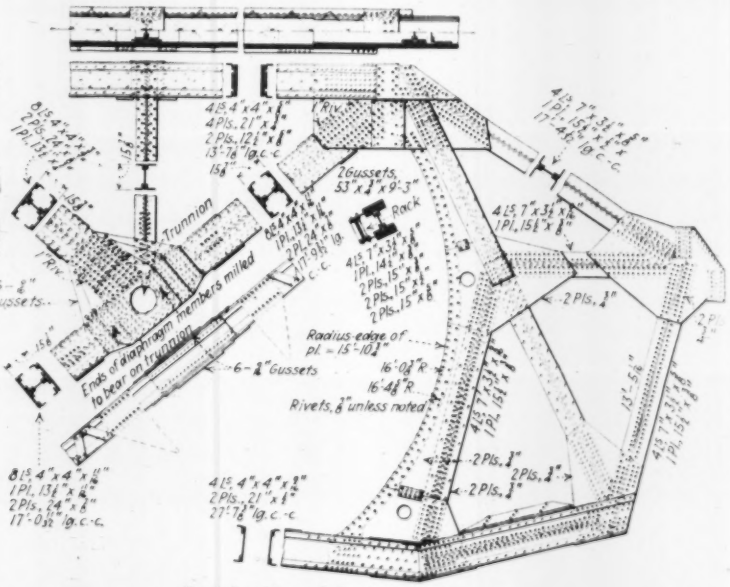
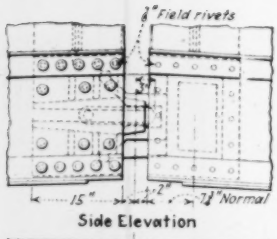
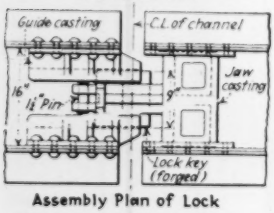


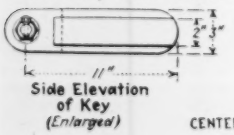
FIG. 3—TRUNNION PIER DETAILS; SUBSTRUCTURE OF PIER (BELOW EL. 13) BUILT 12 YEARS AGO

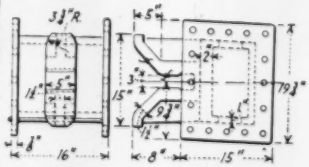



Trunnion
Rack
26 gussets, 53" x ½" x 9'-3"
6 - ½" Gussets
Ends of diaphragm members milled to bear on trunnion
Radius edge of pl. = 15'-10½"
6 - ½" Gussets
16'-0½" R
16'-4½" R
Rivets, ⅞" unless noted
Heel-Section of Bascule Truss

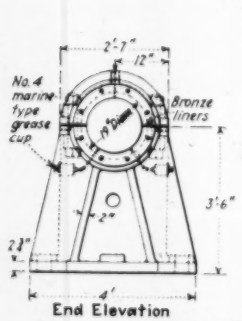


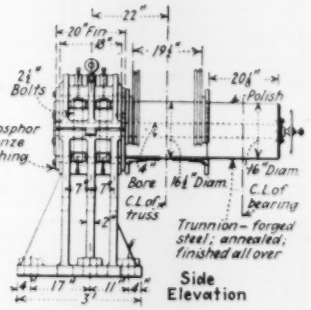


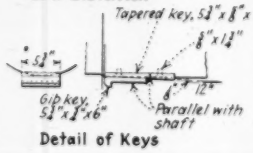


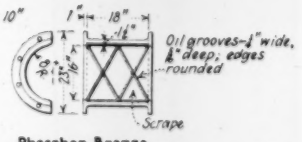


CENTER LOCK CASTINGS

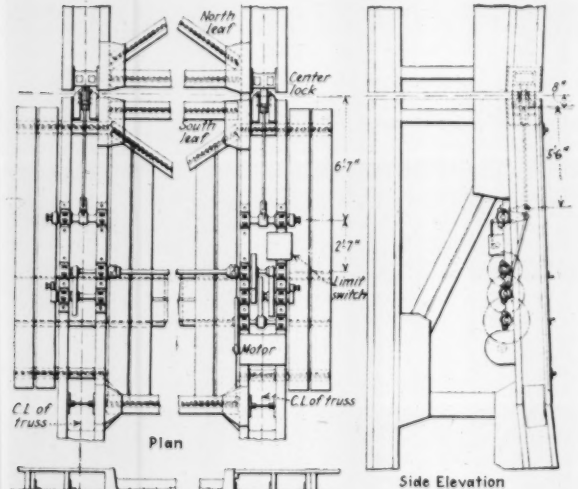


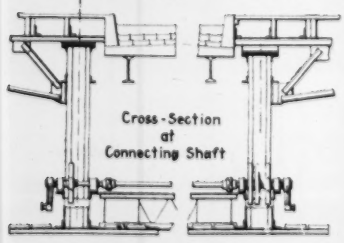




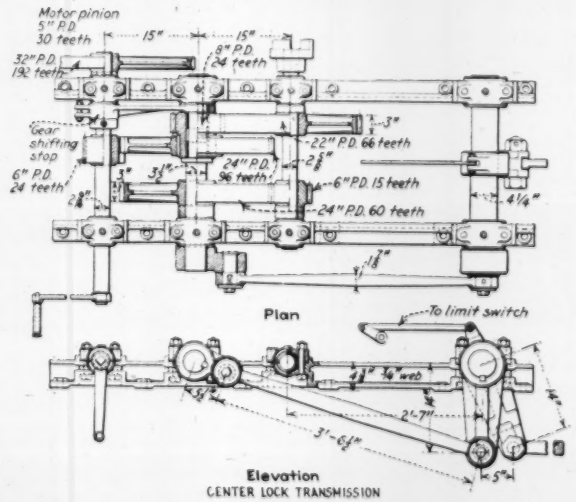


TRUNNION AND PEDESTAL BEARING





DETAILS OF CENTER LOCK MACHINERY



CENTER LOCK TRANSMISSION

FIG 4—TRUSS DETAILS, CENTER LOCK, AND TRUNNION AND PEDESTAL BEARING

open position. The floor load, amounting to about 210 tons, is taken up at every second panel point by a light horizontal girder, instead of being carried wholly at one end as is common practice. The horizontal girders at alternate panel points transmit the load to the top chord of the truss partly through the top lateral system and partly through the end connection of the girders.

Of the machinery details, the trunnion and trunnion pedestal bearing are shown in drawings herewith. A drawing is also shown of the novel center lock, which was designed by J. A. Dunford, of the bridge department of the city engineer's office, and has proved very satisfactory. It comprises a pair of jaw castings attached to one leaf of the bridge, and horizontal keys or lock pieces sliding between horizontal guides in the

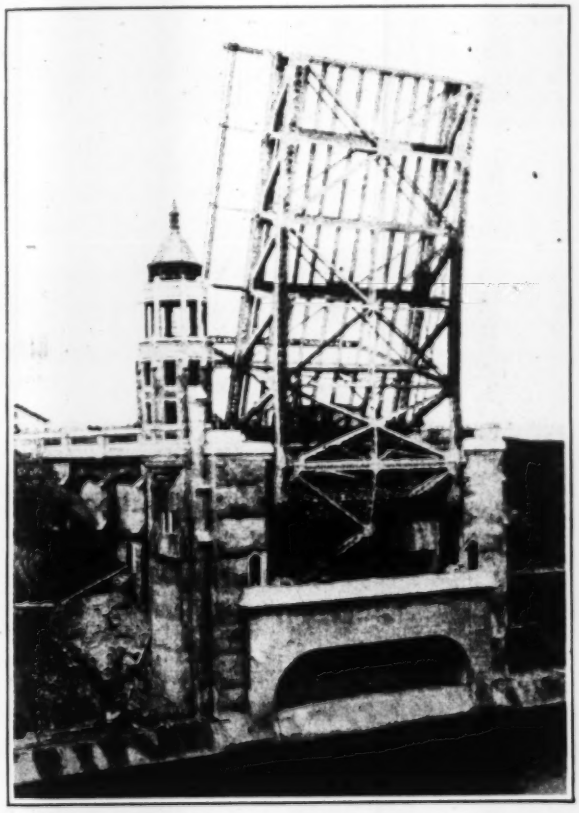


FIG. 5—TRUNNION SUPPORT AND FORWARD BEARING

end of the other leaf, these locks being actuated each by a pitman driven by a high-reduction gear train with electric motor drive and emergency hand drive. There is in actual use no apparent play between the two leaves.

The bridge is at the east entrance to the grounds of the University of Washington, its towers rise more than 100 ft. above the water and can be seen from a considerable distance. Therefore much attention was given to the architecture of the concrete approaches and the operating towers. The architectural treatment shown was adopted on the recommendation of a committee of three architects.

The design of the Montlake bridge was worked out and construction was supervised by A. Münster, acting bridge engineer, city of Seattle. J. D. Blackwell is city engineer of Seattle, and D. W. McMorris is assistant engineer in charge of bridges.

Road Subgrade Not Improved by Soil Adulteration

ADULTERATION of subgrades with cement or lime compounds as a means of improving sub-base conditions by securing stability in heavy soils is ineffective and uneconomical, says a report to the California Highway Commission. The report was made by Research Engineer C. L. McKesson, to the state highway engineer, after a study of experimental sections on the Rio Vista lateral, Solano County, placed in 1921 and 1922.

The special subgrade treatment was undertaken in an effort to determine, if possible, an economical method of treating adobe to eliminate its swelling and plastic condition when saturated with moisture, and its subsequent shrinkage and cracking when dried out. The plan tried called for the thorough mixing with the subgrade, in varying quantities and depths, of portland cement, hydrated lime, limestone dust, and asphaltic oil.

The work was started in 1921, and the pavement was completed during the summer of 1922. Twelve sections, with one exception 500 ft. long, were chosen and an effort was made to select those with soil conditions as nearly identical as possible. An examination shows the soil to be adobe and silty clay, varying in quality.

The treatment consisted of loosening and pulverizing the subgrade to a depth of 6 and 12 in. after which the various adulterants were mixed with the soil and well worked in. Except on the experimental sections, a 4-in. gravel sub-base was placed on all heavy soil on the paving project. It is possible, therefore, to compare this more or less standard method of subgrade treatment with the various experimental admixtures. An 18-ft. concrete slab 5 in. thick was placed.

Commenting upon the Rio Vista lateral experiments, Mr. McKesson states that they appear to justify three conclusions, which he sums up as follows:

1. Soil adulteration with cement or lime compounds is not an efficient or economical method of securing stability in heavy soils.

2. The suitability of soil for subgrade purposes, or of the merits of various methods of soil treatments, can be determined by relatively simple laboratory tests; and expensive field tests, in some cases at least, can be avoided by first resorting to a properly conducted laboratory investigation.

3. A sand or gravel layer is an efficient and economical method of minimizing damage to pavement, resulting from swelling or shrinkage of the subsoil.

In making his report, the engineer calls attention to the fact that the results of the California tests are similar to those obtained by A. C. Rose, who conducted like experiments for the U. S. Bureau of Public Roads at about the same time. The federal experiments were made with Cove clay, a soil similar to the adobe of the Rio Vista lateral, in this state. In the report of his tests, Mr. Rose makes the following statement:

Adulterating the subgrade with a lime compound or sand to a depth of one foot reduces shrinkage in the portion adulterated, but the subsoil for a considerable depth beneath this treated layer would continue to swell and shrink and displacement of the upper layer and of the pavement would doubtless continue, although to a less degree. The efficiency of this method of subgrade treatment is doubted.

It is believed that a better treatment of heavy soil subgrade is:

1. To use a sand cushion to act as an equilibrant to run into irregularities of the subgrade, which is deformed by shrinkage or swell of the soil, and thus to maintain a uniform surface in contact with the base of the pavement, or

2. To establish an unchanging moisture content in the immediate subgrade.

Water Power Investigations by the Geological Survey

Methods of Collecting Data on River Flow and Geological Conditions Which Are Necessary for Preliminary Engineering Work

By B. E. Jones
Hydraulic Engineer, United States Geological Survey, Washington, D. C.

THE water-power resources of the United States amount to 55,000,000 hp., of which only about one-sixth has been utilized. The federal government is in a position to control the development of 85 per cent of these resources, through its ownership of lands and its right to regulate interstate commerce on navigable streams. The federal control can probably best be exercised in insuring the ultimate complete development of the remaining potential power. In fact, this policy has been enacted into law in the federal water-power act, which requires that a license for a water-power project shall be issued only on the condition that the project shall, in the judgment of the Federal Power Commission, be best adapted to a comprehensive scheme of improvement and utilization for the purpose of water-power development, navigation, and other beneficial public uses. Such a condition presupposes sufficient information as to possible beneficial uses to warrant a determination whether the project will or will not form a proper unit in a general plan for comprehensive development and use, and federal water-power investigations should be sufficiently detailed to supply this information. However, the cost of even preliminary investigations that would supply this information for the whole United States would be so great that funds can be provided only for the absolutely essential data. These data fall naturally into three divisions—water available, surveys, and geologic conditions.

The amount of water available is the first consideration in an investigation of a water-power project, and records for at least ten years are necessary to give a reliable estimate. For this reason the collection of records of stream flow must precede by many years the work of construction, in order to avoid mistakes due to poor estimates of water available. The minimum requirements under the head of surveys would consist of a topographic survey of the river and more detailed surveys of possible dam and reservoir sites. Geologic examinations at dam and reservoir sites give an idea of conditions governing security and possible water-tightness of foundations, and although they are not absolutely essential in preliminary examination, they are not very expensive and are certainly worth the cost. Finally comes making the information available to the public.

This article is written to show how the U. S. Geological Survey has been collecting these essential data, what it is now doing, and what it would like to do.

River Surveys—Topographic surveys of rivers to assist in a study of their power resources are being made as rapidly as funds permit. The usual scale of the resulting maps is 2 in. to 1 mile. The contour interval differs according to the topography, but unless the stream bed is very steep the interval is 5 ft. on the water surface and 20 or 25 ft. on land. Where power development by means of a conduit seems feasible the survey is carried to a height sufficient to show the general conditions for the location of a canal, in some places as much as 1,500 ft. above the river. Profiles of rivers are prepared in the office and published with the maps. Reservoir sites are mapped on the usual scale of 2 miles to 1 in., but the contour interval on the land is reduced to 10 ft. for flat areas and 20 ft. for larger and more precipitous sites. Small reservoir sites are mapped on scale of 1,000 ft. to 1 in. Dam sites are mapped on a scale of 200 or 400 ft. to 1 in., and usually the mapping extends for 1,000 ft. upstream and downstream from the site. All these scales can be changed to suit local conditions. The maps showing the results of these surveys were until recently published in water-supply papers but are now being published separately.

Stream Gaging—Daily records of stream discharge are now obtained at about 1,700 gaging stations scattered throughout the United States. Of these stations 760 are equipped with automatic gages. The stream-flow data are published in water-supply papers, which, including reports on other phases of the country's water resources, now number about 550 volumes. This work is done for the most part in co-operation with states and other public agencies, which contribute heavily to its support.

Hydraulic Studies—In connection with the river surveys a hydraulic engineer is assigned to study the conditions along the river with reference to irrigation and power development. He should make a reconnaissance of the river to select dam and reservoir sites and should determine whether the development will probably be effected by low dams and conduits or by a series of higher dams. He should write specifications for the surveys of dam and reservoir sites, giving the scale, contour interval, and heights to which the topographic survey should be carried. He should obtain a general idea of conditions in the river basin, such as market for power or crops, damages, and value of lands, which will enable him to write a report outlining the resources and the most feasible method of development.

Geologic Examinations—Preliminary studies of the geologic conditions at the proposed reservoir and dam sites are made by geologists. A report based on such an examination gives a description of the formations exposed in the reservoir and at the dam site, an estimate of the probable conditions for foundations, and an estimate of the exploratory drilling that will be required to give precise information on the geologic formations that underlie the site. The factors bearing on the watertightness of the reservoir and on the seepage through the abutments of the dam can usually be determined in such a reconnaissance examination. Predictions can also be made as to the rocks likely to be encountered and the water conditions and timbering in any tunnels that may be proposed.

Future Work—Estimates of the flow for all the larger streams in the United States should be the main object of future work. Estimates based on anything except actual records of runoff are not reliable. A record to be of much value should cover a period of 10 years or more, and obviously such records must be collected in advance of development. The establishment and operation of additional gaging stations, however, require increased funds, and a bill is proposed authorizing sufficient funds for the Geological Survey to expand its stream gaging on a nation-wide basis.

The most useful work under the head of surveys would be to complete the surveys of all the large rivers

of the country within a reasonable time. The river surveys are made in the same manner as the other topographic surveys, but in more detail. Congress in the Temple Act has provided for the completion of the topographic map of the United States in twenty years, and in the interest of economy and efficiency it is planned to make in connection with this work detailed surveys of rivers and of dam, reservoir, and power sites.

Preliminary geologic examinations at the most feasible dam and reservoir sites are all that are justified in advance of definite proposals for construction, but where the site is suitable and a market is available, detailed examinations to locate points for drilling are warranted, and perhaps on large projects, such as those on Colorado, Columbia, and St. Lawrence rivers, some exploratory drilling might be done.

Preparation of Reports—The Geological Survey has heretofore devoted most of its energies to the collection of data in the field and to making the data available in water-supply papers, river-survey maps, and geologic reports. However, estimates of potential water power and plans for making it available as electrical energy are becoming increasingly necessary in connection with the administration of the public domain, and it would seem advisable to prepare these estimates in a manner that will make them as useful as possible to the public, particularly to engineers, and to make them available by publication or by opening them to public inspection. Most reports prepared by the Survey are retained in manuscript form in Washington, but some of the more useful results are published. A provisional outline for reports by engineers of the Geological Survey is given below. Each report is prepared in accordance with the requirements on the river under investigation, but the outline will serve to indicate in general what is included and what is omitted.

I. Preface.
II. Summary.
III. Introduction.
IV. Geography, geology, and physiography.
  a. General description including geologic history of basin.
  b. Meteorologic phenomena.
  c. Factors affecting hydraulic structures.
V. Water supply.
  a. Variations in stream flow.
  b. Annual yield, minimum flow by years.
  c. Magnitude of floods.
  d. Prior water rights.
VI. River control.
  a. Storage required.
  b. Developed storage sites.
  c. Undeveloped storage sites.
  d. Summary.
VII. Water-power sites.
  a. Developed water-power sites, description and summary tables.
  b. Undeveloped water-power sites.
    1. General description of sites.
    2. Water supply without storage.
    3. Water supply with storage.
    4. Capacity of site.
    5. Possible installation, load factor, etc.
  c. Summary.
VIII. Market.
IX. Recommendations.
X. Appendix.

The preface, summary, and introduction need not be discussed here. Under "Geography, geology and physiography" the conditions in the whole river basin are discussed. The same subjects are treated more in detail in the discussion of the individual power sites. Under "Water supply" the records of runoff for the river and tributaries are summarized and analyzed. Under "River control" reservoir sites are described, capacity curves are drawn, and the effect of storage on stream flow is estimated. A summary is prepared showing the additional horsepower that can be developed through storage and the benefits to irrigation, navigation, and flood protection. Developed water-power sites are described only briefly. In manuscript reports undeveloped sites are described in detail if they are of sufficient importance to justify it, and in published reports this information is summarized. The water supply with and without storage for 50 and 90 per cent of the time is stated, and pondage is discussed.

A feasible method of development is outlined, the head available is estimated, and the horsepower available 50 and 90 per cent of the time is computed by using the formula $HP = 0.08\,QH$, in which Q is the discharge in second-feet and H is the static head in feet. This formula is based on an average overall efficiency of 70 per cent. The market for electric power is discussed very briefly. The distances to the nearest large cities are usually given, and some reference is made to the companies supplying the market at the time of the preparation of the report. A detailed study of rates, competition, and probable earning capacity is not attempted. Recommendations usually refer to the best use of the government lands involved and to questions of interference between power and other uses of the water. Tables and curves used in analyzing the water supply and computations are given in the appendix.

Publication of Reports—In general only a few persons are interested in river surveys and reports on water power. For this reason the policy of the Geological Survey is to publish only the more useful general reports and brief summaries of smaller reports. Press notices are used to a considerable extent in an attempt to reach as many persons as possible, but this method is not wholly satisfactory, as newspapers will print only matter of general interest, and as a rule only the newspapers in the immediate vicinity of the area covered by the report print the notices. The result is that many interested persons do not know of the existence of the reports. It has been found that reports that have been summarized or quoted in the technical magazines that are otherwise well advertised have a circulation four or five times that of less advertised reports. The results of reconnaissance river surveys are not published, but white prints of the maps are included in the power reports on the area surveyed and can be supplied at cost to anyone interested.

Results—To date 16,000 miles of river courses have been surveyed by the Geological Survey, and maps of many dam sites and reservoir sites are on file in the office at Washington. In addition to the river surveys the standard topographic maps are of great value in studying reservoir possibilities, drainage areas, diversions from one drainage basin to another, and other features relating to power. The gaging stations now being maintained number 1,673 and from 1895 to 1924 roughly 25,000 station-years of stream-flow records were obtained. Thirty-four reports on water power and river surveys have been published by the Geological Survey, and several hundred manuscript reports, a large number of which are open to public inspection, have been prepared and are in its files.

Principles of Soil Mechanics: III—Determination of Permeability of Clay

Validity of Darcy's Law—Slichter's Formula and Hazen's Observations—Permeability of Sand—Experiments on Clay—Darcy's Law Valid Even for Semi-Solid State

By Dr. Charles Terzaghi
Professor of Civil Engineering, American Robert College, Constantinople, Turkey
Temporary Lecturer at Massachusetts Institute of Technology, Cambridge

WHEN water percolates through a permeable body of prismatic form in parallel flow, its rate of flow is expressed by Darcy's formula, $Q = kFs$, where Q is the volume of flow per second, F is the cross-section of the body, and s is the hydraulic gradient, equal to loss of head divided by length, or h/l. The coefficient k (dimensions cm.^{3}/sec.) has been called the *coefficient of permeability*, and represents the velocity of percolation under a hydraulic gradient of unity.

The law is valid for laminar flow only, and therefore does not apply to the (turbulent) flow of water through coarse gravel. Some have claimed also that it is not valid for flow through clay. But it is generally accepted as applicable to flow through fine and medium sand under moderate head, as it agrees fairly well with experimental data.

Void-Ratio and Permeability—The voids of a permeable body constitute in effect a system of capillary tubes. Percolation velocity depends on the size of the tubes. A sand of definite grain size may have wide or narrow voids, according to whether the structure is loose or dense, and the coefficient of permeability thus depends on density of structure as well as on grain size.

Many years ago Prof. C. S. Slichter[1] made an attempt to compute the coefficient of permeability of sand, assuming uniform globular grains; according to the arrangement of the spheres, the volume of voids ranges between limits of 26.0 and 47.6 per cent of the total volume of the mass. His formula was $k = 771d^2/c$, where d is the diameter of the spheres in centimeters and the factor c has for a temperature of 10 deg. C. values as follows:

$$\text{Volume of Voids} = \frac{\text{Voids}}{\text{Total Volume}} =$$

n,	0.26	0.28	0.30	0.34	0.38	0.42	0.46

$$\text{Void-Ratio} = \frac{\text{Voids}}{\text{Solid Volume}} =$$

e,	0.352	0.388	0.428	0.515	0.612	0.723	0.850
Factor c,	84.30	65.90	52.50	34.70	24.10	17.30	12.80

Thus, the coefficient of permeability of a mass with a volume of voids of 46 per cent (very loose arrangement of the spheres) becomes $60.3d^2$ at 10 deg. C. But Allen Hazen has found by experiment that the coefficient of permeability of a very clean and loose sand amounts to $116d^2_w$ (d_w is effective size of the grains according to his well-known definition), and, if the grains are of approximately the same size, even $150d^2$.

The disagreement between the theoretical value obtained by the formula of Slichter and Hazen's experimental results is due to the fact that the voids of Slichter's filter are supposed to be equal among themselves, while in practice each filter contains wide and narrow voids. It can be proved that at equal volume of voids and equal size of grains the coefficient of permeability decreases with increasing uniformity of voids. On the other hand, the relation which exists for any one kind of sand between the density and coefficient of permeability agrees fairly well with Slichter's theory.

In order to represent the theoretical relation, the void-permeability curve S in Fig. 1 has been plotted. It corresponds to a mass consisting of microscopically small spheres of equal diameters. The upper and lower ends of the middle section of the curve (void-volume 47.6 per cent, void-ratio 0.905; void-volume 26 per cent, void-ratio 0.352) indicate the extreme limits within which Slichter's formula is valid. The geometrical part of the theory of Slichter has been further developed by L. Darapsky and L. Burmester[2]; but, as the shape of the grains of natural sands is irregular rather than globular, elaborate theoretical investigations of such a kind are at best of academic value.

Permeability of Sand—As Slichter's formula for the permeability coefficient is rather complicated, I derived a semi-empirical formula based on the following facts: The widest parts of the capillary channels through which the water flows have at least five times the cross-section of the narrowest ones. Hence, if a definite quantity of water percolates through one of the capillary channels, the loss of head per unit of length of the narrowest sections of the channel is at least 25 times greater than the loss per unit of length of the widest ones. Due to this, the percolation of water through sand can be compared to the flow of water through a set of sieves in series: the resistance to percolation is confined to the sieves while in the spaces between sieves the resistance is negligible. Let d_w be the effective size of the grains (cm.), n the void-volume, v_o and v_t the coefficients of viscosity of the water at 10 deg. C. and at temperature t respectively, and C an empirical coefficient found by experiment to range from $800\,v_o$ to $460\,v_o$ depending both on the shape of the grains and on the uniformity of the sand; then

$$k = \left(\frac{C}{v_o}\right)\left(\frac{v_o}{v_t}\right)\left(\frac{n - 0.13}{\sqrt[3]{1-n}}\right)^2 d^2$$

$$= (800 \text{ to } 460)\,\frac{v_o}{v_t}\left(\frac{n - 0.13}{\sqrt[3]{1-n}}\right)^2 d^2$$

The value 800 was derived from tests on sands whose grains were well polished and rounded, while the value 460 was from tests with sands of irregular, rough grains. The influence of the uniformity of the sand upon the value of C was far less marked than the influence of the quality of the grains. Within the limits of void-ratio 0.352 and 0.905 (void-volume 26 0 to 47.6 per cent) the curve of permeability on void-ratio plotted by means of the formula just given coincides closely with the corresponding curve plotted from Slichter's formula (Fig. 1), *provided* they are drawn so as to have one point in common. It may surprise the reader

to learn that two apparently very different methods for calculating the relation between the volume of voids and the coefficient of permeability furnish similar results. But it has been found by experience that any simplifying assumptions concerning the shape and the arrangement of the capillary openings lead to results agreeing fairly well with each other and with the observations, provided the nature of the material has been taken into consideration appropriately. This fact considerably facilitates the interpretation of the results of tests.

Basing calculations on the formula, one can reduce any coefficient of permeability to a volume of voids of 50 per cent (void-ratio 1.0) and to a normal temperature of 10 deg. C., regardless of the actual density of structure of the sample. The coefficient of permeability thus obtained is called the *reduced coefficient of permeability* k_r. By introducing into the formula the special values $n = 0.5$ and $v_o = v_t$, one arrives at $k_r = (174$ to $100)\ d^2_w$. As the value k_r is independent of both temperature and voids, it is a value which may serve as a basis for investigating the influence of the quality of the grains and of the uniformity of the mass upon the permeability of the material. The values 174 and 100 seem thus far to represent the extreme limits for these influences, provided the sands are perfectly clean, without any traces of clay. Even a very small quantity of clay was found to upset the validity of the formula. For checking the formula obtained by theory, and for determining the value of the empirical coefficients, the relation between void-ratio and coefficient of permeability had to be investigated by experiment.

Tests of Permeability of Sand—In order to get accurate results care must be taken that neither the sand nor the water system contains air. I use a cylindrical filter (Fig. 2), the sand resting on a diaphragm of brass wire mesh. Provision is made for sending water through the sand either upward or downward. Before the sand is introduced the water is allowed to rise above the wire mesh, and bubbles adhering to the mesh are removed by exhaustion. The sand is thoroughly wetted before it is placed in the cylinder. If, during the test the water flows upward, the rim of the cylinder serves as overflow. However, most of the tests were made with the water percolating downward. The loss of head is measured by a graduated standpipe, communicating with the space below the wire mesh. The data required for making a complete report on the results of the test are surface area and thickness of the layer, method of preparing the layer (sand loosely poured in, stirred, compacted) volume of voids, average specific gravity of the grains, temperature, sieve analysis, effective size of grains, shape of grains, values of percolation and loss of head. Basing on the results of numerous tests, the formula expressing the relation between void-ratio and permeability has been checked and verified.

Permeability of Clay—If the grains of clay differed from those of sand only in size, our formula could be used for computing the coefficient of permeability of both pure sand and pure clay. But it was found that the finer constituents of clay consist of very thin, flexible mineral scales, while the grains of sand are bulky and rigid. The capillary channels of sand accordingly have a rather compact cross-section, while those of clay resemble narrow slits. This difference has an important influence on the mechanics of the percolation process. A theoretical study of the flow of water through powders with scale-like grains[3] led to the formula

$$k = \left(\frac{C}{v_o}\right)\left(\frac{v_o}{v_t}\right)(e - 0.15)^2(1 + e)d^2$$

where e is the void-ratio, or ratio of volume of voids to volume of solid matter. Considering the verified accuracy of the formula for sand, the present formula might also be expected to be adequate. However, before empirical data for verifying the formula could be obtained, it was necessary to develop a method for determining experimentally the coefficient of permeability of clay.

Clay Tests—Measuring the permeability of clay is more difficult. The first systematic attempts seem to have been made by American engineers (testing materials for the Lahontan dam, Cold Springs dam, Palouse project[4]). In most of these tests the material was put into a cylindrical vessel and compacted by tamping. The height of the layer was usually about 100 cm. Below the layer of soil there was a filter. The water percolated vertically downward. In principal the apparatus was identical with that shown in Fig. 2, and it would fully serve for determining the coefficient of sand. But when applied to clay the method is open to serious objection.

Experience has shown that the coefficient of permeability of clay varies within extraordinarily wide limits, according to the volume of voids. As soon as a soil mass composed of crumbs of clay comes into contact with water, the crumbs swell and the volume of voids increases. Within the test cylinder this swelling is restrained to an unknown extent by friction along the sides of the vessel and it is doubtful if the volume of voids of the sample is identical with that of the soil in the dam. Furthermore, the samples unavoidably contain much air. Even if one shakes a sample of powdered clay with water in a bottle, a considerable quantity of air continues to stick to the clay particles and one cannot drive it out except by boiling the solution. But in the dam the air contained in the soil is gradually carried away by the percolating water in solution, while the laboratory test never lasts long enough even partially to exhaust the air out of a sample 100 cm. thick. Last but not least, one must consider that a crumb soil, as used by the investigators, contains voids much larger than the coarsest individual particles of the soil. Water percolating through such a mass carries in suspension the fine particles detached from the crumbs located near the upper surface of the sample, and the formation of a "filter skin" becomes inevitable. As soon as a filter skin is formed, no more conclusions can be drawn from the results of the tests regarding the permeability of the samples. It is very doubtful whether the coefficient of permeability of clay crumb soils can be determined at all except by indirect experimental methods.

In order to exclude these sources of error I constructed the apparatus shown in Fig. 3. Air can easily be excluded from the interior of the apparatus; the diameter of the clay sample is much greater than its thickness, hence the friction along the sides of the sample has practically no influence on the volume of voids; and the moisture content of the sample is maintained constant by keeping the sample under a constant pressure.

The apparatus consists of a vessel in which an internal rim rests on a perforated bronze plate, whose upper side is covered with a fine brass wire mesh. The plate

supports a sand filter covered with a circular sheet of thin filter paper. In order to perform the test, one fills the vessel with water, introduces the bronze plate, removes the air bubbles from the wire mesh, fills the space above the mesh with clean quartz sand (size of grains 0.5 mm.), and covers the surface of the filter with filter paper. In the meantime the ring shown seated on the vessel has been partially filled with a plastic, homogeneous mixture of water and clay, about 2.5 cm. thick. This ring is applied to the top of the vessel in such a way that the air may escape when the ring is lowered, and is then clamped down by a gasketed bronze ring. The upper surface of the clay sample is covered with paper and a sand filter. This is loaded by a lever. The water-filled space below the perforated bronze plate communicates with a standpipe 100 cm. high, 0.6 cm. in diameter.

Under the influence of the load on the clay, the moisture content of the sample decreases, until equilibrium is reached. Then one fills the standpipe with water and the water percolates upward through the clay. As a rule more water evaporates in the small annular space around the loading plate than comes up through the clay. Hence it is necessary to keep the water-level in the annular space constant by occasionally adding water. In the standpipe the water-level falls during the test at a decreasing rate. I make readings three times a day and compute the coefficient of permeability from the rate at which the level sinks.

Three tests are run simultaneously, at loads of 60, 125 and 190 kg. (0.75, 1.6 and 2.4 kg./cm.^{2}). As a rule four to six weeks are required for the contents of the standpipe to filter through a fairly fat clay. After each reading, the temperature of the water is read from a thermometer whose bulb is enclosed within a brass pipe (not shown on the drawing) which passes across the vessel below the perforated bronze plate. As changes of temperature have marked effect on the elevation of the water level in the standpipe, the tests must be made in a cellar with a very constant temperature. A fourth simultaneous test is run in an apparatus of somewhat different type, containing a sample at about the lower limit of the liquid state, not loaded, the water filtering through the clay in downward direction from a standpipe over an opening in a bronze plate clamped down on the gasketed upper rim of the cylinder which contains the clay. After the test the clay in each apparatus is sampled and its moisture content determined.

Homogeneous mixtures of clay and water were used only. As the width of the voids of such samples is equal to or less than the diameter of the smaller individual particles, no filter skin can be formed, provided the water used for the test is perfectly clean.

In order to investigate whether a filter skin forms in these tests, parallel tests were run with samples of different thickness. If a filter skin formed, a thin layer should show a smaller coefficient of permeability than a thick one, since the passage of water through the filter skin is not affected by the clay below the skin. But the tests gave the same coefficient of permeability for a thin as for a thick layer. Again, after a test on a liquid-plastic sample, the surface was scraped off and the test was repeated, without any change in result.

In the moisture-permeability curves in Fig. 1, those points whose ordinates were determined by means of the apparatus shown in Fig. 3 are indicated by circles. For moisture contents approaching the lower limit of the plastic state the coefficient of permeability became exceedingly small, so that it could no longer be reliably determined in a direct way. In order to overcome this difficulty and to make it possible to investigate the permeability for the semi-solid state of the clays also, I was obliged to work out an indirect method, which enables the permeability of almost impermeable samples to be measured comparatively rapidly. This method will be described in a subsequent article. It is distinguished by the fact that the water merely circulates in the interior of the sample, without entering or leaving it, since during such a process no filter skin can possibly

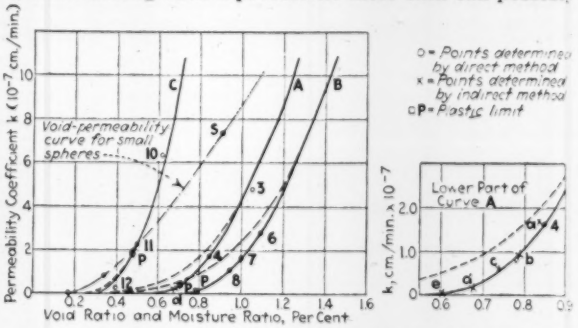

Permeability Coefficient k (10⁻⁷ cm./min.)
Void-permeability curve for small spheres
o = Points determined by direct method
x = Points determined by indirect method
P = Plastic limit
Lower Part of Curve A
k, cm./min. x 10⁻⁷
Void Ratio and Moisture Ratio, Per Cent

FIG. 1—PERMEABILITY-MOISTURE CURVES FOR THREE CLAYS

be formed. The close check between the points *a* and 4, Curve *A*, Fig. 1, furnishes a conclusive additional proof for the results obtained by means of the apparatus Fig. 3 to be reliable.

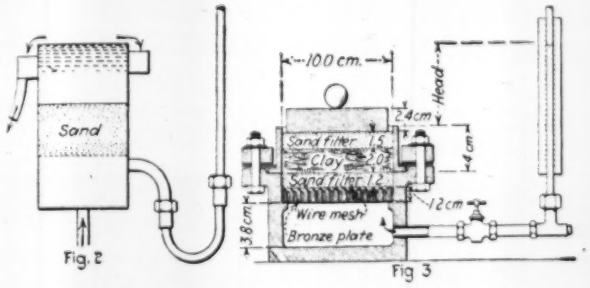
Darcy's Law Valid—Tests with the apparatus just described proved that Darcy's law holds for percolation through clay of plastic consistency. In addition it may be inferred from certain of the results that it is also valid for the flow of water through semi-solid clays. Distinct departure from Darcy's law could be noticed only for semi-liquid clays. Reducing the hydraulic grade from 50 down to 10 or 15 caused rapid decrease of the coefficient of permeability, and only at low heads was the coefficient fairly constant. This phenomenon, however, may be explained by the fact that the structure of a semi-liquid clay is honey-combed. The void-ratio of the loosest possible aggregation of equal spheres amounts to 0.91 (volume of voids 47.6 per cent), while for a semi-liquid mass of clay it is approximately 2. The structure of such a mass is stable merely because initial friction* keeps the particles in relative position, and the average width of the voids is far greater than the average diameter of the clay particles. When water percolates through such a mass under a considerable head it produces elastic and non-elastic deformations and grain displacements similar to the deformations produced by a stream of water forced through a system of very expansible rubber tubes, but at lower hydrostatic pressure the elastic deformations disappear and the coefficient of permeability changes accordingly.

Hence we can state that Darcy's law is valid at least for the flow of water through clays with a medium or a low moisture content (plastic or semi-solid consist-

*NOTE—The term initial friction has been used by the author for indicating the shearing strength the clay has, if it does not stand under the influence of any pressure (neither external nor capillary). It amounts to at least 10^{-6} dynes per point of contact between each pair of clay particles.

ency). It remains to be examined whether or not the permeability coefficients agree with the formula given above.

Departure from Theory—Fig. 1 contains the results of three sets of permeability tests. In order to compare these results with the formula, I determined first such values of $\frac{C}{v_o}$ and of d_w as would make the curve fit the test points 1 to 4 (curve *A*, points 1 and 2 outside of the figure). Then, with the same value of $\frac{C}{v_o}$, I determined two other values for d_w, to fit the respective groups 5 to 8 and 9 to 12 (curves *B* and *C*). If the



FIGS. 2 AND 3—MEASURING PERMEABILITY OF SAND AND CLAY

Fig. 2—Apparatus for sand. Fig. 3—Apparatus for clay.

formula is correct, the points of each set ought to be close to the corresponding theoretical curve. For medium moisture contents the curves and the points agree fairly well, but for moisture contents approaching the plastic limit the disagreement increases rapidly, and for the semi-solid state the coefficient is only a small fraction of the theoretical value. The plastic limit (limit between the plastic and the semi-solid state) is marked in the figure by the letter *P*. The anomaly becomes particularly obvious when comparing the relation between the void-ratio and the coefficient of permeability of sands with the results of the clay tests. Increasing the void-ratio of a sand from 0.6 to 0.8 increases the value of *k* by 75 per cent, whereas the same increase of the void-ratio of the clay increases the coefficient of permeability by several thousand per cent.

For reasons which have already been discussed, it seemed inadmissible to blame such important disagreement merely upon the approximate character of the assumptions. On the other hand there was reason for suspecting that the disagreement is due to a physical factor, one not present in flow of water through sand but appearing only when the voids are very small. If the disagreement were due to error of the formula, it ought to manifest itself whenever the void-ratio drops below some certain value but instead, it is invariably associated with the semi-solid state of a clay, regardless of whether this state (plastic limit) is reached at void-ratio 0.3 or 1.0. Experience has shown that the moisture content of a clay corresponding to the plastic limit increases with increasing fineness of the grains, provided the grains are of similar kind, so that it seemed likely that the plastic limit is reached as soon as the width of the voids drops below a definite critical value, regardless of what the effective size of the grains may be. If that be true, the observed anomaly concerning the permeability too should be in some way related to the width of the voids dropping below a certain critical value.

Change in Viscosity—From this reasoning it seemed that the physical constants of the water might change when the capillary channels of a shrinking clay become reduced to a certain size. This supposition was strengthened by anomalous results obtained in certain evaporation tests.

Prisms made of different clays were allowed to dry at normal temperature (15 to 25 deg. C.), and their loss of weight was determined three times a day, together with the shrinkage of the prisms (distance between gage-points on their surfaces); at the same time the loss of weight of a cylindrical vessel containing distilled water with a wide, free surface was measured. Basing my calculations on the data thus obtained, I computed for each one of the prisms the ratio between the speed of evaporation of the capillary water and the corresponding speed of evaporation of the water contained in the vessel (relative speed of evaporation). The results of the computation were plotted in a diagram (Fig. 4) the abscissas of which represent water content (void-ratio) and ordinates represent the relative speed of evaporation. The letter *P* indicates the plastic limit, *N* the point at which the surface of the capillary water retires into the interior, and *S* the shrinkage limit. Down to the plastic limit the relative speed of evaporation was constant, at about 1.1. But between *P* and *N* the speed of evaporation decreased, though the surface of the capillary water remained at the surface of the prisms.

Thus, one of the physical constants, the relative speed of evaporation, changes after the state *P* has been reached. It has already been remarked that the surface tension of the water changes its value at this same point. Under these conditions I felt warranted in concluding that the physical constant which determines the speed of percolation, i.e., the viscosity of the water, also changes its value as the clay approaches the lower limit of the plastic state.

Deducing from the observed facts the law which connects width of voids and coefficient of viscosity, we obtained the law

$$v_o' = v_o \left(1 + \frac{R}{s^2}\right)$$

where v_o denotes the normal value of the coefficient of viscosity and v_o' the viscosity of the water flowing through a capillary channel $2s$ (cm.) wide; R is a constant of value between the limits 6×10^{-12} and 2×10^{-12} (its exact value has not been determined, but knowledge of the limits is sufficient for our purposes). In voids smaller than 0.1μ (0.0001 mm.) the value of the coefficient of viscosity increases rapidly.

Revised Permeability Formula—Because of this change in viscosity the formula for permeability of clay had to be modified, the result being,

$$k = \left(\frac{C}{v_o}\right)\left(\frac{v_o}{v_t}\right)\frac{(e-0.15)^n\,(1+e)}{(e-0.15)^3 + \frac{c}{d^2_w}}\,d^2_w$$

It is obviously difficult to determine the effective size d_w of the grains of clay because it requires wet mechanical analysis of the material. But as the formula expresses the relation between water content and permeability it can be used even when d_w is not known. The only requirement is that we know the result of a single permeability test on the sample of clay under

study. This one result, the value k of the sample at one particular moisture content, may be used to determine the value k at any other moisture content, the two values being connected by the law expressed by the formula given.

Thus suppose we have two clays, for one of which the effective grain size d_w is m times larger (m being unknown) than the grain size d_w of the other one. In addition, we suppose that the permeability of the clay with the grain size d_w be given by the formula

$$k_1 = 3.34 \times 10^{-7} \left(\frac{v_o}{v_t}\right) \frac{(e - 0.15)^n (1 + e)}{(e - 0.15)^s + 0.0166} \text{(cm./min.)}.$$

According to what precedes, the permeability of the clay with the grain size md_w should be

$$k_2 = 3.34 \times 10^{-7} \left(\frac{v_o}{v_t}\right) \frac{(e - 0.15)^n (1 + e)}{(e - 0.15)^s + \frac{0.0166}{m^s}} m^2 \text{(cm./min.)}.$$

By making a single permeability test with the second clay, one point of its moisture-permeability curve is obtained, and this point permits of solving the above equation for m. Knowing the value of m, the complete curve can be drawn from the formula and subsequent permeability tests should plot close to this curve. Curve B in Fig. 1 is an example of what agreement may be

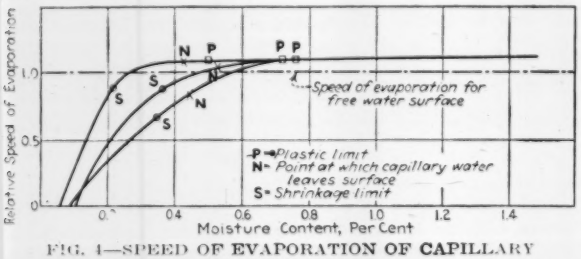


FIG. 4—SPEED OF EVAPORATION OF CAPILLARY WATER OF CLAY

expected. For one point of this curve the test furnished the value $k = 40 \times 10^{-7}$ cm./min., while the formula gave the value 35×10^{-7} cm./min. In the case of curve C, Fig. 1, the agreement between theory and test results was less satisfactory, on account of the high sand content of this material, amounting to 59.1 per cent. Such a soil may be called a sandy mud. Nevertheless its permeability also proved to vary between extraordinary wide limits as its density varies. This further illustrates that one cannot possibly describe the permeability of a clayey material except by a moisture permeability curve; a single figure means nothing.

Individual Character of Different Clays—For clays having equal grain size, the plastic limit may be high or low according to the shape of the grains and to the degree of adsorptive saturation. Therefore the values of the constants C and c in the general formula for the permeability coefficient depend on the nature of the grains as well as on their size, and an expression of the numerical type as just quoted is not valid except for clays whose grains are fairly similar in character. If the water which percolates through the clay contains substances in solution, these substances are adsorbed by the clay, and the solute accumulates along the surface of the clay particles. The concentration of the solution influences considerably the viscosity of the solvent, and in turn the viscosity of the solvent has a marked effect upon the permeability of the medium.

Attention should be called once more to the important fact that the preceding discussions apply only to homogeneous mixtures of clay and water. Crumb clay soils do not belong to this class. Percolation through such soils inevitably leads first to the formation of a filter skin and then to the filling up of the widest voids with spongy colloidal matter, detached from the top layers of the crumbs. Hence percolation through crumb soils is associated with grain displacements, internal erosion and deposition. It is a very complex phenomenon, which still needs careful investigation. It is altogether inadmissible to simply apply to the hydraulics of crumb soils the conceptions derived from sand filter tests or those applicable to homogeneous clays.

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[1]C. S. Slichter, Annual Report of U. S. Geological Survey, 1899, p. 311.

[2]"Filtergeometrice," by L. Darapsky, *Ztschr. für Mathematik u. Physik*, 1912, p. 170; "Geometrische Untersuchung der Bewegung des Grundwassers im Gerölle und der Wasserfilterung durch Sand," by L. Burmester, *Ztschr. für angewandte Mathematik u. Mechanik*, 1924, p. 33.

[3]Erdbaumechanik, by K. Terzaghi (1925).

[4]Verbal Communication of R. R. Coghlan, chemist in charge; "Experiments on Material for Cold Springs Dam, Umatilla Project," by D. C. Henny and E. G. Hopson, *Eng. News*, 1907, p. 250; "Experiments on Cold Springs Dam and for a Projected Dam Which Was Abandoned," by T. A. Noble, *Eng. News*, 1907, p. 490.

Utilization of Sewage Sludge Report to Two Societies

Progress in Several Cities and Sewerage Districts—Special Outlets for Sale of Sludge—Present Research

Identical Report of Committee on Sewage Sludge made in October, 1925, to the Sanitary Section, American Public Health Association, at St. Louis, by Langdon Pearse and to the American Society for Municipal Improvements, at Des Moines, by Samuel H. Greeley.

ACTIVITY in the investigations of the disposition of sewage sludge and the decided progress made during the year in the data secured impel your Committee on Sewage Sludge to submit again a progress report. The outstanding features of the progress made during the year may be briefly stated:

Increased interest in the use of sewage sludge on the part of the agriculturist and fruit grower. Remarkable demand upon the part of golf clubs, flower growers and fertilizer manufacturers for the organic nitrogen in the sludge when reduced to a dry basis so that it can be properly handled. The cities of Rochester and Baltimore are disposing of the sludge from their hydrolytic and Imhoff tanks, after air drying, to neighboring truckers and fruit growers who haul it away and pay something for each load. The North Shore Sanitary District near Chicago is paid $100 per year by a farmer for the privilege of removing and using the dried Imhoff sludge from the drying beds of three separate sewage disposal plants which serve a very considerable population. Activated sludge, when properly prepared by drying and grinding, is sought by many different types of users.

Special Markets for Sludge—The Milwaukee Sewerage Commission, with the co-operation of the Sanitary District of Chicago, has, for the past two seasons, distributed prepared activated sludge, free of cost, for trial to many golf clubs in the Detroit, Cleveland, St. Louis, Minneapolis and Milwaukee districts—57 in all. In the majority of cases, the clubs have tried to get sufficient sludge this year for their total fertilizing needs but little being available their requests could not be complied with. The Milwaukee Sewerage Commission has also distributed to many flower growers in Illinois, Michigan and Wisconsin the prepared sludge with the result that a very considerable tonnage has been requested by this type of user. For 18 months truckers in large numbers have been attempting to secure activated sludge without success because it has not been manufactured in sufficient quantity. The investigations so far con-

ducted on the fertilizer value of activated sludge have been broad and have embraced the feeding of many types of ground growing staple crops, such as corn, tobacco, potatoes, tomatoes and cereals. In most cases, the several types of ground and crops have satisfactorily responded. For the growing of lawn and bent grass it has been especially successful. It proves better than sodium nitrate in that a surplus does not burn the grass and there is a very decided residual value in the sludge which is not in the nitrate. It is better than manure in that the plant food is more concentrated and contains no harmful seed to inoculate the soil, or injure the grass. The best market, however, is with the fertilizer manufacturer who uses it as a filler to supply the organic nitrogen needed in the best complete mixture. Synthetic and mineral nitrogen are great plant foods but are not equal to organic nitrogen which has for years been largely supplied by the packing house industry in the form of tankage and which, since the war, has been converted largely into live-stock food.

The production of activated sludge to date has been very small and has been practically confined to the Calumet and Maywood sewage-works of the Sanitary District of Chicago and to the plant of the city of Houston, Texas. These plants have produced approximately 40 to 50 tons per month, although not continuously. The city of Houston has sold some of its sludge for $12 per ton f.o.b. cars at the sewage-works. The Sanitary District of Chicago has received for its sludge in 100-lb. bags $22.50 per ton f.o.b. cars near works. The Milwaukee Sewerage Commission will not be ready to begin the production of the dried sludge from its plant until late in October. The indications are that from 1¼ to 1½ tons of dried sludge will be produced from 1 m.g. of Milwaukee sewage or approximately 100 tons per day. Provision has been made to store the dried sludge through the off season (from May to October) in a substantial storage building of 25,000 tons capacity. By this means the sludge can be held for delivery when the demand is greatest and the price the highest.

Dewatering—For the purpose of dewatering the sludge and preparing it as a commercial product, demonstration plants have been conducted at Pasadena, Houston, Milwaukee, Indianapolis and Chicago. These plants have embraced pressing, filtering and drying. The McLaughlin filters were used at Houston and Pasadena; the Worthington, the Berrigan improved press and the Simplex press at Chicago; the Oliver continuous filter at Pasadena, Milwaukee and Chicago, and the American continuous filter at Indianapolis, and, on a small scale, at Chicago. Milwaukee has built and Indianapolis has under construction the most complete dewatering plants. The Oliver continuous filter and the Atlas dryer are to be used at Milwaukee and American filters and Bonat dryers are being installed at Indianapolis. It is felt that the problem demands considerably more research before standardizing upon any one type of dewatering plant or equipment.

Sulphur, alum and sulphuric acid have been successfully used in assisting the coagulation of sludge preceding filtering or pressing. Chicago appears to secure the best results from alum, Houston from sulphur, Milwaukee from sulphuric acid. Recently, Chicago has experimented with ferric chloride which appears to be more efficient but more expensive so that its use might not be warranted except in an emergency. Neither in Chicago nor in Indianapolis has it been found necessary to heat the sludge artificially prior to dewatering during the winter months whereas heating has been found necessary in Milwaukee to get the most efficient results. It therefore appears that each situation of considerable magnitude must, at present at least, be given separate study and investigation before any final determinations as to the best method for dewatering the particular sludge in question. As yet recovery on a small scale appears too costly a procedure. Several tests are now being conducted, with considerable progress, upon the possibility of digesting activated sludge by means of single or two-storied tanks.

Utilization of Activated Sludge—As a temporary measure, Indianapolis is digesting activated sludge in the same tanks with primary sludge produced by fine screens and rapid settling. This mixture of raw and activated sludge, when inoculated with partially digested sludge, produces very rapid gasification and complete digestion within a relatively short period. In the design of the dehydration plant at Indianapolis, provision is made for the drying of digested sludge which is expected to be the ultimate means of disposing of primary sludge composed of fine screenings and sludge continuously removed from preliminary settling tanks. The drying plant at Indianapolis is practically completed. The development of the sludge filter plant, except for the installation of one full-sized American continuous unit, will be delayed until the economic value and the cost of dehydration are more completely established.

Dr. Imhoff, in the Ruhr District, and the engineers of the Sanitary District of Chicago are discharging the excess activated sludge into the sludge or bottom chamber of Imhoff tanks where it settles and mingles with the digesting primary sludge. Digestion has taken place. While additional sludge capacity is required in the primary tanks, this combination of Imhoff tanks followed by activated sludge may have possibilities and offers a way of solving the sludge problem both for small and large installations. Further investigation is needed. Dr. Imhoff proposes, in the activated sludge plant he is now designing in the Ruhr District, to dispose of the sludge in primary digestion tanks and utilize the gases formed by the digestion process as power for compressing the air for the purification process. If this proves successful, it will be a long step forward both in reducing the cost of purification and the cost of disposing of the sludge.

In England, sewerage-works engineers have been interested in the commercial utilization of sewage sludge for many years. The late Mr. Garfield, at Bradford, used to ship the dried sludge to Florida in shiploads. Mr. Hart, in Leeds, has pressed the precipitated sludge and sold it to the neighboring farmers. Mr. Watson at Birmingham has also carried on commercial disposal of digested sludge. A portion of the precipitated sludge from the Davyhulme Works at Manchester has been reduced to dryness on steam-heated steel plates and sold to farmers. Birmingham has recently been disposing of the sludge from its drying beds by delivering it to a nearby fertilizer manufacturer who uses it as a filler in mixed fertilizer. An abandoned aerodrome furnishes a convenient factory. Many other English cities are using some method of disposing of their sewage sludge to increase the value of neighboring farms. In the larger works, the practice of dumping wet or press cake sludge upon land and plowing it in is gradually being abandoned in England, although for the small works it is still a very common method.

Research — Engineers everywhere are still seeking an advantageous way of disposing of the most troublesome product of most types of sewage treatment. If methods are finally discovered for economical, and perhaps profitable, disposal of the sludge from both large and small activated sludge plants, this process may become more available than it now is. However, additional research is needed in the problem of sludge disposal both as to procedure and equipment.

The thought is somewhat prevalent that if the activated-sludge process of sewage treatment becomes broadly used on a large scale, the production of the fertilizer from this source may cause a decrease in selling price. This may be a possibility but, as the demand now exists, there are few sources from which this demand for organic nitrogen can be supplied. If, after continual trial, the activated-sludge product meets the requirements it now promises to meet, the indications are that a market can be found at a price which should cover the cost of preparation. At the present juncture, your committee urges caution in the consideration of plans for new projects. As a rule, financial considerations are foremost. While Milwaukee, Chicago, Indianapolis, Houston and other cities are carrying on research and are operating large works, the knowledge obtained must be applied to a given problem, whether large or small, by experienced engineers. The economies effected, if any, may prove available only on the large scale.

The committee realizes that this report may be deserving of criticism because of the prominence given to activated sludge. The reason is that this character of sludge is of recent origin. Much research has been and is being carried on to determine the best methods for handling it and those particularly interested are entitled to such facts as the committee has been able to accumulate.

Pavements Salvaged By Widening and Resurfacing

Rough and Narrow Chicago Streets Being Converted Into Adequate Trafficways Serviceable for Another Decade by an Asphalt Topping and Expansion Sideways

WIDENING and resurfacing old pavements receive careful consideration in Chicago as a means of meeting a demand for betterment which conflicts with a strained economic condition. Like all cities Chicago has experienced in the last two or three years an enormous increase in street traffic. Thoroughfares adequate only a few years ago are entirely inadequate now partly because of weak pavement structure but chiefly because of poor surface and lack of width. The need of improvement is urgent. There is not the money for entirely new construction as rapidly as improvement is demanded. Pavement widening and resurfacing are acceptable means in many instances, it is held, of meeting the emergency. As a result there has developed a well-thought-out theory and practice of pavement widening and resurfacing which street engineers can study to advantage.

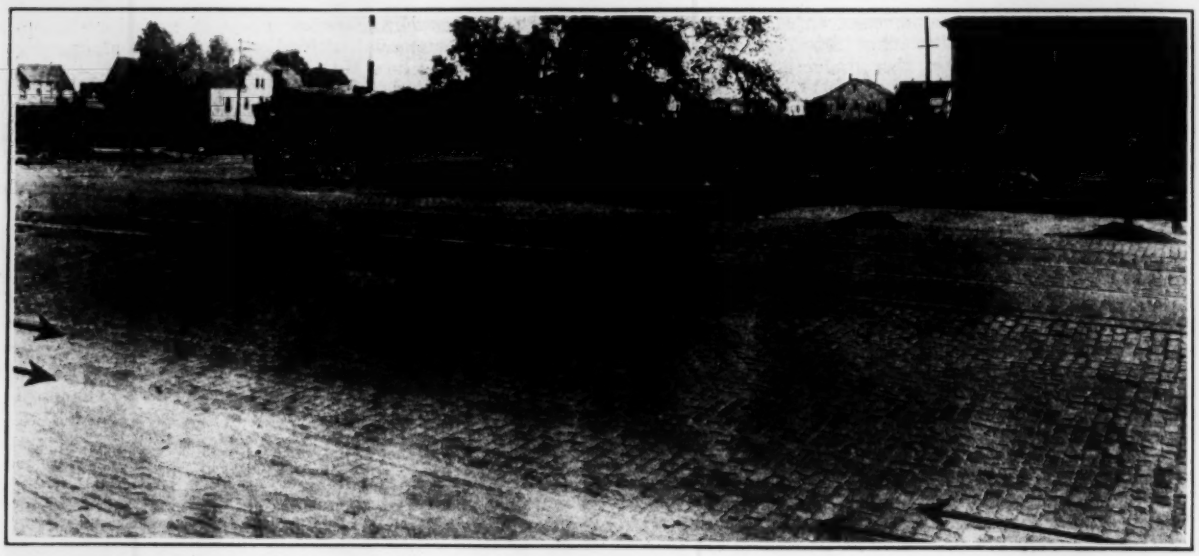


FIG. 1—OLD BRICK PAVEMENT WIDENED BY NEW BRICK
Arrows indicate the zone where the old and new brick surface are joined

Widening and resurfacing call for definition as they are understood in Chicago practice. There are two cases of widening: (1) Completely new construction, with the widening, comprising new pavement, new curbs and new surface structures generally; and (2) utilizing as great a part of the old pavement as possible and extending it by new work to the increased width. It is the second case of widening only which is considered here. Resurfacing also contemplates using the old base as it is or perhaps flattened at the crown, and topping it with a new surface. These definitions are important to keep in mind.

Theory of Resurfacing—Resurfacing is not expected to give as good a pavement, in structure, in riding qualities, in drainage or in appearance as new construction. There are expected a lower initial cost, a greatly improved street and, let it not be overlooked, the possibility of comparatively quick improvement. There has to be counted also the fact that by postponing new construction for maybe a dozen years, advantage can be taken of new types, or improved construction practices or, possibly, cheaper prices. The lower initial cost appeals to the property owner and so does the postponement for he feels that he may sell in the ten years for which the resurfacing lasts and then someone else will have to pay for the expensive new construction. Resurfacing projects, therefore, get quick approval compared with proposals for new pavement. To summarize, then, resurfacing (1) offers economy, (2) causes less disturbance of existing improvements and (3) results in less controversy. There are also offsetting faults. These warrant further specification of advantages and disadvantages as disclosed by Chicago experience.

The economy of resurfacing comes from several things: (1) There is a saving of the cost of a new base partly offset by the cost of preparing the old base, (2) cost of excavation is saved, (3) costs of curbing, sewer adjustment and sewer connections are saved, and (4) quick opening of the street saves traffic costs. Obviously, with the old street structures undisturbed except for new surfacing, there are no private property changes required and of course no challenge of street grade or width because they are unchanged. With old conditions undisturbed, also old faults of line and grade, poor drainage and obsolete design are perpetuated. There is uncertainty of the strength and durability of the resurfaced pavement and finally the engineering planning is greater.

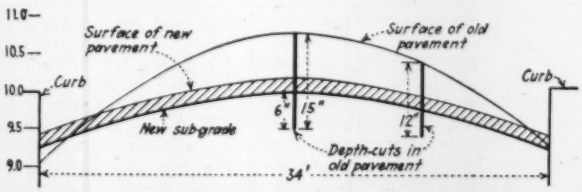


FIG. 2—CROSS-SECTION FOR PLANNING RESURFACING

Planning Resurfacing Projects—In planning to resurface a street, subsoil conditions have first to be considered. Within two or three miles of the lake the soil is sandy and beyond this zone it is clay. A thicker remaining base for the new topping is necessary on the clay subgrade. The bearing of this fact appears in thinning down the old base at the crown. Old pavements and particularly old macadam had far steeper crowns than are now permissible practice and they have to be cut down for the new topping and yet left thick enough to give ample base strength. In Chicago practice the minimum safe thickness is put at 7 in. for sand subsoil and 8 or 9 in. for clay subsoil.

In brief the problem of planning resurfacing is to place a surfacing of comparatively flat crown on a base with a steep crown leaving all other street conditions —curb levels, grades, and drainage—as they existed and not reducing the old base to an unsafe thinness at the crown. Crown thickness of the flattened base remaining decides the feasibility of resurfacing. In many instances it proves not feasible and a new pavement has to be provided. To determine the feasibility of resurfacing even more engineering study is required than in planning new pavement.

The most common experience in Chicago is resurfacing old macadam on residence streets. The first survey task is to make depth cuts, at each summit and inlet, at the crown and the quarter points. Depths are noted and locations marked on street plans. In case the old street is paved the test cuts are not so frequent but in all other respects the methods are the same. Cross-sections are then taken at test pits and other changes of grade with elevations at curbs, gutters, quarter points and crowns. Other surface conditions are noted as they seem important. Then in the office cross-sections and profiles are made and the study begins for the final plans.

FIG. 3—WIDENING OPERATION ON BRICK STREET
The view shows the notched edge of the old pavement with which the new brick work is interlocked.

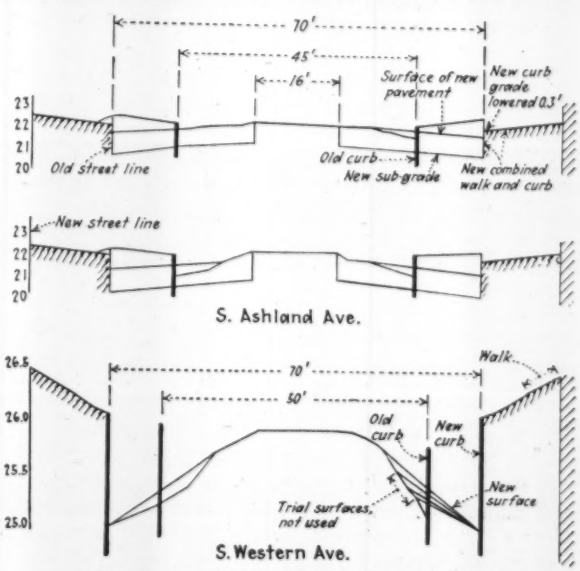


FIG. 4—CROSS-SECTIONS FOR STUDYING WIDENING PLANS

In some cases, establishing the new crown is a straight-forward operation but commonly curb depths, crown profiles and grades have to be juggled about until the best plan is arrived at. Fig. 1 is an example of a cross-section developed from the field and office studies. In this instance the new surface had to be raised an inch and the circular arc of crown changed to a parabolic arc to get the necessary remaining depth of base.

Construction and materials involve nothing unusual. An asphalt topping is nearly always used as it can be laid in thin sheets and the irregularities in the old base can be smoothed up with black base. The chief requisite in construction is care and good supervision. There are so many irregularities in the work that continual inspection is essential.

Widening Theory and Practice—The preferred design

for widening is a crowned roadway with gutters at the sides. This design has been employed wherever practicable. In a few instances, however, it has been necessary to leave the old gutter as it was and to carry the widening up on a rising slope to a very shallow curb exposure. This design has certain advantages in economy and in eliminating high curbs where the street is already low but its faults are so many that it is used only when there is no other resource. As noted at the outset the theory of widening is to utilize as largely as possible the original street structure. This may be some part or all of the old pavement or only the old base. Sometimes the widening is on both sides and sometimes all on one side. The planning is a task of adapting requirements to conditions in each street.

Planning Widening Projects—Even more precise surveys are employed for widening than for resurfacing. At every summit and valley a cross-section is taken with levels every foot or two. At intersections diagonals are leveled. Every street structure is located and noted. The street is then platted and trial profiles are drawn until the best practicable surface has been worked out. Some of the transverse section plats are shown by Fig. 2.

Construction Methods—Except that particular attention has to be paid to certain operations construction is according to usual methods. To be noted particularly is the importance of cleaning up all débris, filling all ditches and keeping the thoroughfare open, as the old roadway is used constantly while the construction proceeds. The necessity of protecting the workmen from traffic is very important. On streets with such dense traffic that it is necessary to widen the roadway this traffic is a serious danger. An item to check carefully where the surface is brick is the width of the individual brick. It should be equal to that of the original or the courses will soon be out of line or they will not "notch in" to the old surface. A difference of only $\frac{1}{8}$ in. will cause serious trouble in a project of this type.

Another item of importance on a brick surface concerns the time when the last two lengths of brick may be removed adjoining the junction between the undisturbed part and the relaid part of the old pavement. The old bricks should not be removed closer than the length of two bricks from this line until the day the new bricks are to be placed. After widening, the surface of the old brick is cleaned and then receives a top dressing of hot asphalt and torpedo sand.

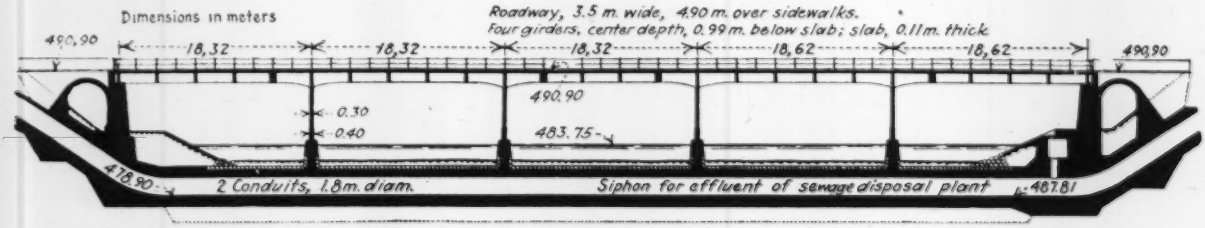
Conclusion—Resurfacing and street widening in Chicago are carried out by the Board of Local Improvements, John J. Sloan, president. John B. Hittell is chief engineer of streets and A. J. Schafmayer is division engineer. This article is prepared from information provided by Mr. Hittell and Mr. Schafmayer.

Concrete Cantilever Bridge Built of High Early Strength Cement

A BRIDGE for light highway service recently built over the Isar River at Unterföhring, near Munich, Germany, contains some noteworthy individualities of design and construction, described in *Der Bauingenieur* of June 10.

This bridge was required as a means of providing roadway connection between two parts of the Munich sewage disposal plant on opposite sides of the river, and its location was chosen directly on the line of a sewage effluent siphon which crosses the stream. This siphon, consisting of two 72-in. concrete conduits, passes through the pier bases of the bridge. The original design for the bridge superstructure contemplated steel construction, but at the last moment reinforced concrete was adopted instead. Dyckerhoff & Widmann, of Munich, who built the structure, chose a cantilever girder design, to suit the particular requirements of the case.

In building the bridge, with a view to rapid construction and in order to avoid danger of destruction of the centering by freshets, they used high early strength portland cement ("Dyckerhoff-Doppel") for the structure. The use of this cement made it possible to strip forms in each span after five days, and permitted completion of the entire structure in 2½ months' working time.



ISAR RIVER CANTILEVER GIRDER BRIDGE COMPLETED IN 2½ MONTHS' WORKING TIME

Relatively light loads will use the bridge, and accordingly the superstructure was designed for a narrow-gage railway using 13-ton locomotives and 4½-ton cars, for 5½-ton highway vehicles, and for a distributed loading of 80 lb. per sq.ft. The desirable span length and the rather soft condition of the subsoil, previously explored during the construction of the siphon, led to adopting cantilever construction in preference to simple or continuous span construction. Expansion is provided at one of the joints in the middle span, while those in the end spans are fixed, as are also the seats of the girders on the abutments. This arrangement was adopted largely because very thin walls (12 in. thick) had been designed as supports for the steel superstructure originally contemplated, and any increase in thickness was undesirable with regard to maintaining full width of waterway for flood flow (extreme maximum flow for purposes of design taken at about 55,000 sec.-ft.).

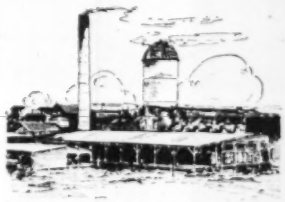
In the construction of the bridge, falsework supports between the piers were avoided by suspending the forms from a three-segment timber arch in each span. Forms were cambered 2 in. at midspan to allow for the flexibility of this construction and about ½-in. permanent camber was obtained.

Engineering in the Small City

A series of notes from the field on the Problems and Practices of the Municipal Engineer in the Cities Below 100,000

The Editor Visits the City Engineer

Snapshots of Our Representative Small Cities



LUMBER MILL, EVERETT, WASH.

Everett, Wash.

EVERETT, COUNTY SEAT OF SNOHOMISH COUNTY, WASH., occupies the end of the peninsula between the Snohomish River and Puget Sound, lying almost opposite the Straits of Juan de Fuca which connect the Sound with the Pacific Ocean. When the city was incorporated 30 years ago the peninsula was largely virgin forest. Rapid development followed the construction of the railroad and fortunately for the future of the city the townsite was laid out with wide streets and a view to industrial development. Lumber is the chief industry, of course, and there are 18 or 20 lumber and shingle mills in the city; among other industries are fish canneries, fruit-packing plants, two paper mills and three steel plants. Pop. 34,000.

THE engineering department in the city of Everett works under two very definite limitations—the annual budget and the system under which the city government functions. The annual budget is now $9,890, which must be made to cover the city's entire "engineering overhead," that is, the salaries of city engineer, an assistant, a draftsman, clerical help, and all equipment, materials, etc. This limitation is relieved somewhat by the fact that all construction is contracted and all incidentals as well as additional men, such as inspectors, instrument men, etc., are charged against the particular improvement on which they are used. There are no alternatives, however, in the system that puts under other departments all matters pertaining to water supply, inspection of buildings, electrical work, supervision of parks, and other functions sometimes assigned to the city engineer.

The city council consists of only three men, all of whom are elected simultaneously every four years. As the councilmen are not often candidates for re-election this usually means that an entirely new city administration comes in every four years. The councilman receiving the highest number of votes automatically becomes mayor. Each councilman, including the mayor, takes charge, as commissioner, of one of the three departments, namely, public works, finance and safety.

The city engineer and the superintendent of the water department are appointed by the council and report to that body as a whole, although in some activities such as street work the commissioner of public works serves as intermediate authority between the city engineer and the council. S. E. Paine has been in the Everett engineering department since 1918 and city engineer for the past two years.

Two things the observant visitor is sure to note about Everett's streets: (1) The arrangement of mushroom traffic buttons at intersections and (2) advertising on trash receptacles provided by the city. The traffic buttons on the intersection of street center lines are illuminated at night by a red light inside the dome-shaped metal grillage; four other buttons, painted red but not illuminated, are also used. These are placed where the property line meets the center line of each of the four intersecting streets and thus define the limits of the intersection. The refuse receptacles, which are marked with the Board of Public Works stencil, are substantially made of galvanized iron and are rectangular in shape which makes it convenient to use each of the four sides for advertising, this space being sold to local merchants. The cans are about 30 in. square and 3 ft. high with an arched cap on either side of which is a 10x11-in. opening for papers, fruit peelings and other trash.

Garbage in Everett is disposed of by the sanitary-fill method similar to that used at Seattle. There has been no difficulty with odors and the only objection has been the rat pest. The fills at the outset were not made as compact as they might have been and the rodents established a colony within the dump itself from which later efforts to dislodge them have been unavailing. A second systematic attempt to exterminate them by poisoning is now being made. Sewage is discharged into the tidewater of Puget Sound without treatment.

Unlike some cities that have built up around a railroad, Everett has not had a serious grade separation problem. The Great Northern R.R. passes under the main business district in tunnel or on tracks in deep cuts across which the streets are carried on steel bridges. The bridges were built by the railroad and an agreement between city and railroad provides that the city shall maintain the decking.

Paving Practice—The 38 miles of paved streets in the city include almost every type of paving. There is still a good deal of wood-block paving, a heritage of days when it was in demand as a silencer for horses' hoofs, but none of this has been laid in recent years. Maintenance has been heavy on various asphalt combinations laid extensively some years ago and much of this is now in poor condition. Since 1916 concrete pavement has been standard and a great deal of it has been put down. This year the 55,000 sq.yd. of concrete laid is in accordance with the usual amount which has been averaging in recent years well toward $250,000 per annum.

A pavement thickness of 6 in. is standard, using a 1:2:3 mix, with no reinforcing except where the foundation is poor. At first the plan was to run a contraction joint clear across the street on spacings varying with street width. After observation of the tendency to crack, 400 sq.ft. has been adopted as the proper area for individual slabs and this is made the basis for laying out rectangular slabs to fit street widths as conveniently as may be. The only maintenance on concrete pavement thus far has been filling in contraction cracks.

Curbs and gutters are cast monolithic and where grades are low gutters are troweled for 18 in. to get a smooth surface that will facilitate drainage. Curbs are given a 1-in. batter which is a great advantage

in facilitating the parking and get-away of automobiles. Another commendable feature of curb design at intersections is the use of ramps, 30 in. wide through the curb from gutter to sidewalk level which is a great convenience for women with baby carriages or young children.

The main business street, Hewett Ave., is 68 ft. wide while in residence districts the street widths range down to a minimum of 20 ft. between curbs. Taken as a whole the street widths average 30 ft. The present practice is to give subgrade and pavement a crown of 0.01 of the street width. This is a reduction from sharper crowning not now believed necessary. Even with this crown there is a decided tendency to crack longitudinally on the center line and hence a longitudinal joint is now always laid along the center line.

The Water Department—Construction, operation and maintenance of the water department are under the direction of Carl Klapp, superintendent, who has been connected with the system for twenty years. Mr. Klapp has been "bought and sold with the system," to use his own words, six times, for in this time there have been many changes of ownership including purchase by the city in 1916. The main source of the present water supply is the Sultan River from which a 28-in. wood-stave pipe line delivers the supply by gravity. The city is divided topographically into medium, low and high-pressure zones, in order to keep the pressure within reasonable limits, but even so in using three auxiliary or pressure-reducing reservoirs the pressure in the lowest zone ranges up to 125 lb. per sq.in. which is believed to be the maximum that can be handled economically.

Steel pipe are used exclusively in the distribution system, some that were laid as long ago as 1891 being still in service. Until two years ago the Matheson lead joint was the standard. Since that time, however, all joints are welded with oxyacetylene torch and this method has been found to be highly satisfactory. As much as 800 ft. of 20-in. pipe in 30-ft. lengths has been welded up on the street surface and then lowered into the trench in one piece. Pipes of all diameters are welded and there is even one instance of a 12-in. line welded into a 28-in. line which has been under 190-lb. pressure for five years. The degree of success attending welded steel lines in Everett may be explained by saying that, including experimental welds made five years ago and all welding in the system during the last two years, there has not yet been a case in which it was necessary to repair a weld.

After welding the joints are recovered with tar paint both inside and out. The inside covering is applied by a burlap swab on the end of a ½-in. pipe in which a kink or sharp bend has been made about 2 ft. from the swab. When the swab has been inserted the proper distance the ½-in. pipe is rotated by means of a handle from the outer end and the kink presses the swab against the side of the pipe as it wipes the joint.

Present practice is to lay mains in the parking strips to avoid cutting pavements wherever possible. Cross-connections under the pavement are usually made by jetting. No difficulty has been experienced in jetting pipe under the widest streets which are 50 ft. between curbs. In one case a 6-in. line was jetted for a horizontal distance of 180 ft., though it should be mentioned that this was through a soft earth fill.

No fresh water is available on the peninsula and hence all industries use the city supply exclusively. About one-third the total demand goes to industries such as sawmills, dairies, canneries, etc. The peak demand in summer is 8.6 m.g.d. or 270 gal. per capita per day. The present supply is to be supplemented shortly and comparative studies are now being made by R. H. Thomson, consulting engineer, of Seattle, as a result of which it is expected that bonds will be voted for a new source.

Engineering Work

Keeping City Streets Clean at a Cost of Fifty Cents per 1,000 Yards

EVERY night except Sunday, the 190,593 sq.yd. of paving in the business district of Rockford, Ill., is swept or flushed alternately. Thus no men are necessary to follow the flusher and clean the gutter as the small amount of dirt is carried into the sewers. During the daytime white wings clean places inaccessible to the sweeper and pick up loose paper and rubbish. The secondary town district and main thoroughfares are swept two or three times each week. Residence streets paved with concrete, brick or bitulithic are swept once a week. Flushing alternates with sweeping of all streets.

Motor-driven pick-up sweepers also clean the macadam streets. Bituminous macadam streets are cleaned as often as the permanently paved streets. Streets treated with oil, asphalt or tar are swept three times a year. Exceptions are through streets which get a cleaning every week.

Cleaning macadam wears out the fiber and gutter brooms rapidly because of the roughness and excessive crown. Most of the old waterbound macadam streets are 30 and 34 ft. wide with crowns of 14 to 18 in. and a slope from the quarter point to the gutter of from 11 to 14 in. As several miles (1,106,000 sq.yd. in 1924) of old macadam streets are oiled each year these pavements get a thorough cleaning.

Two truck operators and two laborers are required to pick up and haul all rubbish picked up to the dump, and to clean such places as are inaccessible to the sweepers. The truck operators help load the truck.

Cost Accounting—Each and every man must fill out what is known as an individual time card, which is countersigned by the superintendent of streets. On this card appears the man's name, kind of work, location of work, number of hours worked, number of loads hauled and capacity of loads.

The sweeper operators mark on their card the name of each street swept, from and to a certain place, whether the street was swept full width or the number of laps on each side, the number of tanks of water used (this being such a small cost it is charged against flushing), the number of hours the sweeper operates, and the date that every new broom is placed.

The truck drivers' and laborers' cards are filled out as follows: The name of each man, kind of work, number of loads of material picked up and hauled to the dump, capacity of each load and the number of hours worked.

Of the Small City

The flusher operator marks on his card the name of each street flushed, from and to a certain place, the number of tank loads of water used, location of hydrants and the number of hours that the flusher operates.

The yard foreman keeps records of all oil, grease and gasoline consumed daily by every piece of equipment owned and operated by the street department.

All the equipment of the street department is under the supervision of a master mechanic, whose duty it is to inspect and repair all equipment, the operator of each piece of equipment assisting with the repair of what he uses. Thus the daily individual time card of the master mechanic and operator of each piece of equipment shows the cost of labor for repairs. All equipment is thoroughly washed, cleaned, oiled and greased once every week, which time is charged against repairs, as it adds materially to the life of the equipment. All bills for repair parts are countersigned and charged to the respective equipment by the master mechanic. All daily individual time cards are handed into the main office (being the office of the engineering department, street department and sewer department) before nine o'clock the following morning. These cards are then checked and the time and kind of work executed by each individual is placed on one large card known as the daily time card. On the reverse side of this card are placed totals for labor, repairs and equipment.

The totals are then transferred to a card index file, which has a card having one line for each day in the year with columns for gas, oil, labor and parts. These figures are totaled each month, and the total cost of labor must balance with the amount of the payroll for the month, and the oil and gas balance with the total shown on the oil and gasoline cards for the month.

The amount of streets flushed and swept is also tabulated on a daily cost sheet, one for the flusher and one for each sweeper. These cost sheets show the exact number of square yards of street flushed or swept daily; the number of miles of streets flushed or swept; the number of gallons of gas, oil and grease consumed by each piece of equipment; the number of gallons of water used by the flusher, the cost of truck service for disposal of sweepings, the cost of labor for truck operator and laborer; the cost of flusher or sweeper operator and cost of any repair parts purchased, together with cost of labor for repairing. The street department pays the water department 7c. per 100 cu.ft. of water consumed. One tank is assumed to contain 200 cu.ft. of water. As soon as a new fiber broom or gutter broom is placed on the sweeper, the cost of each broom which was replaced is reduced to a daily cost, which cost is then placed on the daily cost sheet. On this cost sheet is marked the daily cost per square yard.

On the first of each month all daily cost sheets for the previous month are tabulated into a monthly cost sheet. On the monthly cost sheet for sweeping are entered the following items: Date, number of hours, cost of gasoline, cost of oil and grease, gutter broom, fiber broom, operators, repairs, truck service, labor, depreciation, total cost per day, number of square yards cleaned, cost per square yard, number of cubic yards picked up, cost per cubic yard and miles cleaned.

The depreciation of the sweepers is computed as follows: The cost of one sweeper is $6,500. The life of a sweeper is assumed as six seasons, which is very conservative, all indications being that a sweeper will last seven or eight seasons. The six seasons constitute a period of 1,170 working days, which results in a cost of $4.44 per day.

Interest at 5 per cent for 1st year on original investment of $6,500	$325.00
Interest at 5 per cent for 2nd year after deducting the 1st year depreciation, which depreciation is $1,083 every year, investment being $5,417	270.85
Interest at 5 per cent for 3rd year investment being $4,330	216.70
Interest at 5 per cent for 4th year investment being $3,251	162.55
Interest at 5 per cent for 5th year investment being $2,168	108.40
Interest at 5 per cent for 6th year investment being $1,085	54.25
Total	$1,137.75

The total is $1,137.75 for a period of 1,170 days or 97 cents per day.

On the monthly cost sheets for flushing are entered the following items: Date, hours, cost of gasoline, cost of oil and grease, operators, water, repairs, depreciation, total cost, number of square yards flushed, cost per square yard and miles flushed.

Depreciation of the flusher is computed from: cost $6,668.25; period, ten seasons of 1,950 working days, or $3.43 per day. The total interest is $1,839.28 for a period of 1,950 days or 94.3 cents per day.

Some of the street cleaning costs are as follows: During the year 1924 two motor-driven pick-up sweepers, operating 3,102½ hours and using 4,223 gal. of gasoline and 1,557 pints of oil cleaned 32,197,094 sq.yd. on 2,776 miles of streets, and picked up 7,499 cu.yd. of material. The average cost per square yard was 41.4 cents per 1,000 sq.yd. or $1.78 per cu.yd. of material picked up. As the sweeper covers 11 sq.yd. per lineal foot the distance traveled was 5,544 miles. The average cost per hour of operating the sweeper was $4.30 and 10,378 sq.yd. were cleaned per hour. Costs per hour were as follows: Gasoline, 22.4c.; oil and grease, 6c.; gutter broom, 20c.; fiber broom, 31.4c.; operators, 71c.; repairs, 52.3c.; truck service for picking up sweepings, 68c.; labor operators of truck and picking up sweepings, 86.1c.; depreciation, 73.1 cents.

Similar figures for the flusher for 1924 are as follows: The flusher operated 1,857½ hours using 3,392 gal. of gasoline, 496 pints of oil and 9,534,000 gal. of water and flushed 44,814,014 sq.yd. of paving at an average cost of 8.6c. per 1,000 sq.yd. The average cost per hour was $2.074, made up as follows: Gasoline, 30.5c.; oil and grease, 1.6c.; water, 47.9c.; operator, 71c.; repairs, 1.5c.; depreciation, 54.9 cents.

Annual costs in 1920 were $30,720 when hand work and teams were used and the business district was covered by eleven white wings, and the residential streets were covered semi-annually. The cost rose to $35,724 in 1921 with the same methods but through streets were cleaned every week in addition. The next year a sweeper was purchased and operated 16 hours a day, at night in the business district and days in residential districts. The cost dropped to $13,316. In 1923 and 1924 with considerable more yardage added the costs were $19,330 and $16,009, respectively. These figures include snow removal but not depreciation.

All street maintenance work in Rockford is handled by the city engineer, Bernard C. Harvey.

Larger Markets and Better Methods for Structural Steel

Fabricators at Meeting of American Institute of Steel Construction Take Up Commercial and Technical Problems — Fireproofing, Earthquakes, Welded Joints and Rivet Heating Discussed

CO-OPERATIVE betterment of the steel fabricating industry was the theme of active discussion at the third annual meeting of the American Institute of Steel Construction, held last week at White Sulphur Springs. At previous meetings the Institute concerned itself almost wholly with commercial conditions. This subject held an important place also at the present meeting, but for the first time technical questions assumed a prominent place. They were represented not only in a number of excellent technical papers, but were also brought to the front by a keynote address of Prof. George F. Swain, of Harvard University, who spoke on "The Need of Further Technical Research in the Structural Steel Industry," and by a committee report which proposed that the Institute enter into systematic study toward better methods in steel construction.

Increased Use of Structural Steel—Two outstanding commercial questions were discussed at the meeting: Extending the use of structural steel, and correcting faults in bidding and other commercial practices.

C. E. Michael (Virginia Bridge & Iron Co., Roanoke) touched upon the former subject in an opening address. After pointing out how the present situation demands co-operation with a view to internal improvement and suggesting that there is need for setting the industry into a proper relation to the consumer, to the engineer, and to its material, he asserted that it is even now well prepared to meet the requirements of an expanding field of application for structural steels. The industry comprises at the present time about 300 shops, representing a capital value of $200,000,000, and produces an annual output of 2,300,000 tons valued at about $250,000,000.

Large fields for the useful application of structural steel remain untouched, according to the report of a committee on improvement in selling methods, headed by J. E. Vogel (Omaha Steel Works, Omaha, Neb.). Dwelling-house construction is prominent among them. Again, the report of C. F. Abbott, executive director of the Institute, and the report of the publicity committee through G. E. J. Pistor (Hay Foundry & Machine Works, Newark, N. J.) dwelt on the fact that the present use of structural steel, although greater than for a number of years past, is far below the fabricating capacity of the country and below that which the merit and wide adaptability of structural steel would warrant. National advertising and direct publicity were advised. Members were urged to use the slogan "Steel for strength and security."

Better Selling and Business Practices—The crucial problem of the industry was graphically illustrated by President Kimbrough in the statement that in one large section of the country all the fabricating shops are full to capacity but none is making a dollar; and that in one instance two representatives of a large fabricating concern offered to a consumer, at the very moment when a competitor was signing his contract, to take the job at $1,000 less than any other offer. An analysis of the problem was presented by Mr. Vogel in the committee report already noted. He declared that the management and policies of the structural steel industry are wrong, and that the fact that fabricated steel prices are 11 per cent lower than in 1924, while cement prices are only 4 per cent lower and lumber prices are actually higher, points out the difficulty. Ambition for tonnage, deficient cost calculation, and narrow-minded competitive practices are responsible. Specific recommendations of his committee include the conduct of an adequate educational campaign, encouragement of better school training for structural steel engineers, the employment of resident engineers in various districts of the country for promotion purposes, and the formulation of a code of business ethics for the industry.

In the matter of uniform cost accounting, no progress was reported by the committee in charge.

Structural Steel Research—"We want to destroy the idea that a 16,000-lb. working stress is a substitute for a college education," said L. H. Miller, chief engineer of the Institute, in opening the discussion of technical subjects at the meeting. He suggested a number of subjects for further technical work. He proposed that the code of practice include a clause providing that the connections of beams be proportioned to the floor loads recommended by the Building Code Committee of the Department of Commerce, but he opposed inclusion of the appendix of the floor load report of that committee, which he declared is dangerous. An architect recently designed a hospital for floor loads of 7 lb. per sq.ft. because the appendix of the report gave this as the highest loading found in actual measurements in hospitals. There is great need, said Mr. Miller, to study floor systems, with a view to developing better and lighter floor slabs. Beam connections should be standardized more effectively. Welding requires study. Fireproofing needs to be defined.

Aubrey Weymouth (Post & McCord, New York), reporting for the committee on technical research, laid down the doctrine that it is an obligation of the organization to supply the user with dependable information on the best design and construction practices in structural steel, and an obligation to the industry itself to determine whether its costs are burdened with unnecessary requirements of fabrication. In all development of better knowledge, he recommended, the Institute should enter into co-operation with other organizations where their paths cross. Present needs suggest that it should organize a research department. A great variety of subjects invites investigation, among them the value of rivets and bolts, the strength of beam seats with and without stiffeners, the makeup and strength of light members, the value of different types of windbracing, the action of windbracing systems and its relation to current methods of analysis, the efficiency of fireproofing, welding procedure and shop layouts therefor, effect of torch cutting and the need for subpunching and reaming with the present grade of structural steel.

Research Principles and Cautions—In an illuminating address Prof. George F. Swain presented a critique of some common conceptions and misconceptions about

technical research. In general, he deprecated research work not directed to a specific and useful objective. "What of it?" should be asked of every piece of research work before it is undertaken, or at least before its results are recorded. Industrial needs, such as those of the field of structural steel, present a multitude of questions of immediate practical import upon which research may be most usefully brought to bear.

Failure of Overheated Rivets—Studies of the behavior of rivets in heating and during driving were reported by A. L. Spencer, Jr., of the Pittsburgh Screw & Bolt Co., Pittsburgh, Pa. Complaints from rivet users that many rivets broke in driving led to the investigation. The study covered work in seven shops, with coal, oil, gas and electric heating forges and with five different grades of rivet steel. A special device was constructed to permit driving rivets under conditions subjecting them to severe alteration of compressive and tensile stress. The general result of the study was to show that overheating, together with vibration in driving, destroys the strength and ductility of the metal and causes rivets to break in driving.

The tests apparatus consisted of two 1-in. flat plates and two ⅝-in. spring-plates arched ½ in.; in driving a rivet through the four plates a powerful spring tension was put upon the rivet, except at the moment of the hammer blow, thus subjecting the rivet during its driving to an alternating compression and tension which would simulate the action resulting in case of loose or poor assembly of the parts of a member in the shop. The four plates were divided on the center line of the rivet hole, so that the rivet after driving could be removed and examined either micrographically or in the testing machine. Tensile and cold bending tests were made on the driven rivets. The rivet metal ranged from 10 to 22 points carbon and 33 to 84 points manganese, and up to 10 points sulphur. The results were substantially the same for each of the grades tested. Rivets heated to a spitting heat either broke in driving or showed low tensile strength or low ductility; rivets heated below a critical temperature in no case broke and uniformly showed unimpaired strength and ductility despite the stress vibration. The critical temperature ranged from 1,975 to about 2,100 deg. F. for the different grades of steel. The shear values obtained were erratic. Microsections showed rapid grain growth beginning at the critical temperature, and at the higher temperatures also frequent internal cracks. Rivets heated in gas forges did not develop trouble as early as those heated in oil forges.

Arc-Welded Building Framework—An extensive application of arc welding to the connections of steel framework in a building was reported by R. A. Storm (Morgan Engineering Co., Alliance, Ohio). Recently the frame of a building in Canton was erected with welded connections throughout. The use of welding by the Morgan company was the outgrowth of attempts to improve their electric traveling cranes, where it was early found that weaving motion of the bridge tended to loosen the scale in the rivet hole and in particular cause the top cover plate to loosen. Tests were made to determine the strength of beads and of welds made in rivet holes. An average strength of about 10,000 lb. per lineal inch of bead was obtained. Actual connections were designed accordingly, for the assembly of plate girders for cranes and for joints of beams, girders and columns. The Canton work included 358 lin.ft. of field weld, with an average of 5½ in. of weld per connection. Its net result was a 23 per cent saving in labor.

Gunite Fireproofing—B. C. Collier (Cement-Gun Co., Allentown, Pa.) described and profusely illustrated the wide range of application of cement-gun deposition to the fireproofing of steelwork and the reconstruction and reinforcement of both concrete and steel structures. A large number of his illustrations showed gunite repair work on disintegrated concrete structures, and he referred specifically to the strong influence of the character of the coarse aggregate on durability.

Strength of Concrete-Encased I-beams—A detailed report on elaborate Canadian tests of the strength of I-beams carrying concrete slabs, with and without encasement of the body of the beam in concrete, was rendered by Prof. H. M. Mackay, of McGill University. Most of these tests have been previously reported in *Engineering News-Record*. They showed that panels of 10-in. I-beams carrying a 4-in. reinforced-concrete slab, with the concrete carried down around the haunches of the beams so as to encase them, gave perfect combined action, the stresses and deflections being quite closely identical with those computed for a reinforced composite. Additional tests were made with 6-in. I-beams to determine the strength of the bond between slabs and the beam flanges. Even a ¾-in. depth of embedment of the flange in the slab, without haunching, showed no failure of the bond up to stresses in the beams which ran up to and beyond 30,000 lb. per square inch. Other tests demonstrated the possibility of developing the reverse moment of stringers across the girders into which they framed, by the action of the slab extending across the girder.

In summary, Prof. Mackay reported that by taking advantage of the co-operation of the concrete with the steel a gain of about 30 to 45 per cent can be realized in design. However, he suggested tests under heavy-traffic service before complete acceptance of the results in practical design.

Earthquake Resistance—Discussions of San Francisco and Santa Barbara earthquake experiences were presented by A. C. Martin, of Los Angeles, and J. L. Clymer, of San Francisco. Both speakers went so far as to declare that steel framework made a 100 per cent showing in both San Francisco and Santa Barbara.

Institute Affairs—An extensive revision of the constitution of the Institute is to be made, including incorporation of the organization. The membership dues, which are on the basis of tonnage production of the members, will be raised from 5c. to a maximum of 25c. per ton at the discretion of the directors, if present proposals go through. The increased fund, it is expected, will provide for enlarged activities, including joint sales promotion and research work.

The Institute is in flourishing condition as to membership, having added 45 members during the year and now comprises 206 fabricating plants, with 98 per cent of the independent fabricating capacity of the country. J. C. Kimbrough was re-elected president.

At the banquet which closed the meeting, Senator George H. Moses, of New Hampshire, made an appealing address on the relation of government to industry, citing numerous instances of the thoroughgoing dependence of the individual's activities on governmental (largely state) dictation and prohibition. He called for a return to the principle of letting every one conduct himself as he thinks best if he does not injure others.

Engineering Literature

A MONTHLY REVIEW OF BOOKS AND A LISTING OF NEW PUBLICATIONS

With Many Drawing and Color Prints

OLD BRIDGES OF FRANCE—By William Emerson and Georges Gromort; With Preface by M. Victor Laloux, Membre de L'Institut. A Series of Historical Examples from Roman Times to the End of the XVIIIth Century. With an Explanatory and Descriptive Text, 24 Reproductions in Color from the Original Watercolors by Pierre Vignal, 35 Black and White Drawings by Louis C. Rosenberg and Samuel Chamberlain, 44 Measured Drawings, Photographs, Diagrams and Maps. New York: The Press of the American Institute of Architects. Printed in France. Portfolio, boards, cloth back; 13 x 18 in.; pp. 124. $25 from The Press of the American Institute of Architects.

About the only engineering structure which has continuously persisted throughout the ages is the masonry arch bridge. The Romans built such bridges two thousand years ago. The engineer of today when he wants a monumental structure builds the modern replica of the Roman arch. Further than that, the old bridges were built to stay and they are to be found wherever civilization marched across the continents. Too rare, however, have been the records of these structures. The traveling architect or engineer has been able himself to see the Pont du Gard or the Pont Royal, but his home-staying brother has had to dig far and deep to find complete stories of the early bridge efforts. Yet those efforts have much which the modern bridge engineer and architect needs, for the early bridge builders found the symmetry and grace which is eternal and had the practical craft which has resulted in their structures remaining still in service.

To reconstruct the art of bridge building in France for twenty centuries has been the purpose of the American Institute of Architects in the publication of the book here noted. It is an admirable effort, admirably carried out. The authors, Messrs. Emerson and Gromort, have carefully selected the best types of four periods in French structural history: the first that of the Romans, the second that of the thirteenth century, the third from the middle of the sixteenth to the middle of the seventeenth century and the fourth from the latter time down to the ending of the eighteenth century. They present short but illuminating descriptions of each of the major structures in each era, descriptions not only of architectural value but in many cases with construction and engineering detail. Accompanying the verbal descriptions there are numerous measured drawings, with the dimensions taken directly from the structures themselves, and a multitude of delightful black and white drawings by Louis C. Rosenberg and Samuel Chamberlain, delicate and lifelike reproductions of the old structures. To crown the whole portfolio are twenty-four 9 x 12-in. color prints from original water color paintings, by Pierre Vignal of the most important of the bridges described. Each of the color prints is on a separate mount the size of the portfolio.

The portfolio would be an addition to any engineer's or architect's library, but it should be a working part of the library of every engineer or consulting architect who pretends to any expertness in the design and construction of bridges.

Special Libraries in the United States

SPECIAL LIBRARIES DIRECTORY (Second Edition)—Compiled by May Wilson, Librarian, The Merchants' Association of New York; Edited by Rebecca B. Rankin, Librarian, Municipal Reference Library, New York City; Introduction by John Cotton Dana, Librarian, Newark Free Public Library. New York: Special Libraries Association, 195 Broadway. Cloth; 6 x 9 in.; pp. 254. $4.

Nine hundred and seventy-five special libraries with the names of their librarians, number of volumes, the class of service rendered, and important subject headings for each library are listed in the new edition of this useful directory. Florida and South Dakota are the only states of the Union not represented. New York State leads with 216 of the 975 entries. Following the detailed information for each library in the classified list are four indexes: subject, geographical, title (names of each library), and personnel, the latter including librarians and catalogers.

Large as is the number of special libraries included, the list is presumably quite incomplete (no claim for completeness is made). Thus under "Engineering" there are but 28 entries. On analysis these fall into engineers, 10; schools, 10; societies, 6; miscellaneous, 2. Although under Scientific and Technical 10 more schools are included, the 20 can hardly cover all in the country, even allowing for those schools which have their engineering and other "scientific and technical" books separate from the general library. As for engineers who have libraries worthy the name, there must be more than ten in this country, although perhaps not many more with librarians in charge, if that is one of the criteria. Also of the many individuals and firms engaged in landscape gardening there must be a score with libraries, yet not one is listed, there being included only one (college) library of landscape gardening and but three other references to sections of libraries on this subject. City planning makes a better showing, with 33 entries in the subject index, but all to sections of libraries. Certainly of the many specialists in city planning a fair number must have libraries devoted chiefly to city planning.

The foregoing comments as to omissions are made with a realization of the diffculties of the task of making up a directory in a new and rapidly growing field. The volume as a whole is commendable. If given the wide support it deserves, its completeness and usefulness will be increased accordingly.

Belgian Relief: A Problem in Distribution

THE COMMISSION FOR RELIEF IN BELGIUM, HERBERT HOOVER, CHAIRMAN: STATISTICAL REVIEW OF RELIEF OPERATIONS—By George I. Gay (C. R. B. Representative, Stanford University). Five Years, November 1, 1914, to August 31, 1919, and to Final Liquidation. Stanford University, California: The Commission for Relief in Belgium in Liquidation. Cloth; 9 x 12 in.; pp. 439; 22 illustrations, including maps of Belgium and Northern France.

The nature and solution of the great problem of distributing relief to over nine million people in Belgium and Northern France during the World War is both summarized and detailed in this large volume. First there is a brief but significant foreword by

Herbert Hoover. Then 8 pp. of text, tables and graphs are used to summarize the problem and its solution. The bulk of the volume is filled with a variety of detailed statistics of all the relief operations, down to the volumes of food and other materials distributed in minor civil divisions. Everything was under close accounting and statistical control, as the report shows. The report has all the more interest to engineers because it was headed by a master engineer, ably assisted by other engineers, and was in unprecedented degree the application of engineering principles and methods to war relief work.

Elementary Bacteriology

REVIEWED BY HARRY E. JORDAN
Sanitary Engineer, Indianapolis Water Co., Indianapolis, Ind.

BACTERIOLOGY: A Text Book on Fundamentals—By Stanley Thomas, M.S., M.A., Associate Professor of Bacteriology, Lehigh University. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6 x 9 in.; pp. 201; frontispiece portrait of Pasteur and 12 halftones and line cuts. $2.50.

The group to whom any text is addressed must be considered in discussing it. Doctor Thomas makes his intent plain thus: "In teaching elementary bacteriology to mixed classes of undergraduate engineers, chemists, premedical students, and general arts and science students, the author has come to a keen realization of the need for a text which treats of the fundamentals of this great science—upon which the chemist, the medical student and the sanitary engineer can build a superstructure of his own specialized knowledge." . . . "The fact must not be lost sight of that medical bacteriology is simply one branch of a science which is of educational and practical value to mankind in many and varied fields of endeavor." It appears that the author has succeeded in his intent. From chapters on the history, classification, morphology, and physiology of bacteria, he leads to a consideration of bacteria in water, sewage, air and soil. Pathogenic bacteria and immunity are considered. The final chapter on bacteria in industry could be materially expanded —even if necessary at the expense of some part of the rest of the text—in order to fill more fully his expressed intent of visualizing the manifold uses of bacterially induced processes. For in this direction lie the developments that may provide greater comforts to coming generations.

Readers of *Engineering News-Record* might prefer more exactness in some of the author's statements in the chapters on Water, Sewage and Hygiene. That "The use of ferric hydrate instead of aluminum hydrate has increased greatly in the last few years" (p. 95) is doubtful. "Chlorine application is usually affected by the use of a perforated carborundum disc" states a condition that "was" not "is"—thanks to the manufacturers of the apparatus. It is hoped that students will not take the following statements too seriously: "The purification of sewage by electric current is finding wide application" (p. 113). "The advantage of electrolytic purification is that rapid oxidation takes place." "In the Landreth process, the lime added serves a double purpose. It aids in sedimentation and also neutralizes the sewage and acids formed during electrolysis." "The sole action of the electricity is to form nascent oxygen which acts as a germicide."

It is a pleasure to note the emphasis laid by the author upon the useful results of bacterial action. It is made plain that their biolytic activity makes them valuable scavengers, that the nitrogen modifiers have an untold value in agriculture, that every year is adding new industries using some bacterial activity as a part of their process. This is much more wholesome diet for students than the unbalanced ration of medical bacteriology so frequently taught.

Control of Malaria and Smallpox

BATS, MOSQUITOES AND DOLLARS—By Charles A. R. Campbell. Boston, Mass.: The Stratford Co. Cloth; 6 x 8 in.; pp. 262; 39 full-page plates of halftones and line cuts; glossary, index. $3.

Malaria prevention by means of bats to eat mosquitoes, the bats to be so housed as to protect them from their enemies while roosting and conserve their excreta or guano as fertilizer, thus making the bats doubly serviceable, is the main thesis of this book. There is a briefer section on dragon flies as mosquito eaters, a still shorter one on bedbugs as the vehicle for spreading smallpox, and there are a few pages on the functions of the spleen, which the author believes "is given to man primarily as a defense against malaria." The portions of the book devoted to bats and dragon flies as mosquito destroyers is heartily endorsed in a two-page Introduction by Ernest Thompson Seton, who says in conclusion ". . . I welcome this contribution by Dr. Charles A. R. Campbell as one of the most comprehensive, intelligent and revolutionary examinations of the question [of mosquito control] ever offered to the public." A foreword to the section on bedbugs and smallpox, by Dr. J. A. L. Waddell, consulting engineer, endorses Dr. Campbell's theories on that subject, including the substitution of bedbug control for vaccination. Dr. Waddell also commends the whole book, as might be expected on learning from the Preface that to Dr. Waddell's "suggestion, persistent urging and kindly stimulation" the writing of the book is due, and that Dr. Waddell "devoted three full weeks" to checking the MS., "polishing its diction" and verifying the re-typed copy.

The section on bats and mosquitoes reviews studies by the author extending through some two decades. It contains much information on the natural history of both the mosquito and the bat which is very interesting in itself and doubly so as a possible contribution to mosquito control. We say "possible" because although Dr. Campbell's devoted work on bats and mosquitoes has been fairly well and widely known for a number of years, it does not seem to have gained much recognition as a practicable means of mosquito control from the many workers in that field throughout the world. Nor does the book contain many data on the physical and financial practicability of the bat-roost plan. Construction cost figures for two or three roosts and yearly amounts and values of the guano produced are given, but there seems to be nothing to indicate how large an area could be controlled per roost. This can be readily excused, if excuse be necessary, in a book which entrancingly reviews a long, single-handed study, carried on at considerable personal money cost and with the sacrifice of much potentially money-producing time.

In one of the later editions which we trust will follow, there might well be provided a succinct introductory section, written with an eye single to the practical aspects of mosquito control, bringing together material

of this kind now scattered through the bat and dragon fly portions of the book, and amplifying it considerably. Perhaps this could be done best by a public health engineer, experienced in mosquito control work and also in the art of so using the dollar as to produce the largest possible returns in health conservation.

Ions in Colloidal Systems

REVIEWED BY ROBERT SPURR WESTON

Consulting Engineer, Boston, Mass.

THE EFFECTS OF IONS IN COLLOIDAL SYSTEMS—By Dr. Leonor Michaelis, University of Berlin, at present Professor of Biochemistry at the Aichi Medical University in Nagoya, Japan. Baltimore, Md.: William & Wilkins Co. Cloth; 5 x 8 in.; pp. 108; 7 line cuts. $2.50.

Dr. Michaelis's book contains the material of several lectures given at various universities in the United States during 1924 to physicians and scientists chiefly. It is therefore an essay in promoting those branches of physical chemistry which physiologists may expect to be the key to the rôle of electrical and colloidal phenomena in living matter. It is of interest to engineers who wish to modernize their ideas of matter, energy and molecular phenomena.

Half of the book is devoted to the explanation of the origin of electric double layers of molecules at surfaces of liquids and solids. Of especial interest to those engaged in water and sewage treatment is a clear statement of the fundamental phenomena of adsorption, flocculation and discharge, and, while the treatment is mathematical, the statements are for that reason even more readily comprehensible by engineers than by physicians and others addressed.

Familiarity with chemical terms or frequent recourse to a chemical dictionary are necessary to an understanding of this otherwise clearly written and illuminating book which, although technical, treats practical applications more than fundamental theories regarding the part which ions play in colloidal systems.

For the Young Railroad Engineer

THE MAKING OF A RAILROAD OFFICER—By Robert E. Woodruff, Superintendent, Erie Railroad. New York: Simmons-Boardman Co. Cloth; 5 x 8 in.; pp. 245; 21 halftones and line cuts. $2.

Young engineers in railway service who are ambitions to become the "chief" some day or the "super" or the "general" would do well to read and study this little book written by a railroad man for railroad men. It describes the pitfalls and problems they have to meet and does clearly what so few young railroad men have had done for them by their superior officers—outlines the essentials of their job. Evidently the first part of the book is largely autobiographical and the many illustrative examples of the railroad man's problems appear to be but the setting down for others' benefit of a record of some of the hard knocks by which the author gained his knowledge of the railroad field. Their very appearance of reality makes them all the more valuable.

The book emphasizes what so many men who have to handle and deal with other men overlook, the study of the other man's personality and the adjustment of words and actions to make the most of his characteristics. And how few men in any position of responsibility do not have to deal with other men? To all who do, even to those outside of the railroad field, this book will have more than a passing interest.

Jacoby and Davis' Foundations Revised

FOUNDATIONS OF BRIDGES AND BUILDINGS—By Henry S. Jacoby, Professor of Bridge Engineering, Emeritus, Cornell University; and Roland P. Davis, Professor of Structural and Hydraulic Engineering, West Virginia University. Second Edition. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6 x 9 in.; pp. 665; 200 line cuts and halftones; extensive bibliography, including periodicals. $6.

When the changes made in a new printing of a book are so extensive as to require a resetting of the type, as has been the case with the book in hand, it may rightly be called a new edition. "Most of the changes," the Preface states, appear as "new paragraphs scattered through the book." The more important new matter relates to piles, piers and abutments, spread foundations, and underpinning. One of the notable features of the first edition was a large number of references to articles in technical books, arranged chronologically under many heads. The Preface states that these references have been "brought up to date," but there are few if any items later than 1922. The first edition was reviewed in *Engineering News*, June 16, 1914, by C. S. Rindsfoos, who characterized it as "a book for the classroom . . . systematic and accurate."

A Scotch Bridge and Its Replacement

THE OLD AND NEW BRIDGES OVER THE RIVER DON AT INVERURIE, 1791 AND 1924—Compiled by Tawse & Allan, C.E. Aberdeen, Scotland: D. Wyllie & Son. Cloth; 8 x 10 in.; pp. 172; many halftones, 9 insert line drawings.

In 1924 a new bridge was built over the River Don at Inverurie, near Aberdeen, Scotland, a concrete bridge of excellent design and pleasing appearance but not exceptional in size or plan. It did replace, however, an old masonry bridge built at the same site in 1791 and reputed to have been designed by Telford. The book noted here is a tribute to the old and new bridges, both of which it describes in much detail. The authors, the engineers who built the new bridge, have delved into the history of the old masonry arches. They found little except that they were not built by Telford, but they did learn something of the engineering of the day, such interesting facts as that the old bridge cost only £2,000, while the new cost around £15,000. The carpenter when the old bridge was built in 1791 got 8 shillings per week for a day which started at 6 in the morning and finished at 6 in the evening, with 2 hr. off for breakfast and dinner, whereas his 1924 confrere got over £3½ per week of 8-hr. days.

American engineers do not write whole books on single bridges, but if they could find the time and the money they might make as interesting a story as this.

Railway Economics and Administration

RAILWAY ACCOUNTING PROCEDURE: 1926 Edition—Edited by E. R. Woodson. Distributed by Simmons-Boardman Publishing Co., New York City. Published by Railway Accounting Officers' Association, Washington, D. C. Imitation leather (stiff); 6 x 9 in.; pp. 885; charts, forms, bibliography, index. $3.

ANALYSIS OF RAILROAD OPERATIONS—By Joseph L. White, formerly Assistant Comptroller, United States Railroad Administration. New York: Simmons-Boardman Publishing Co. Flexible; 6 x 9 in.; pp. 381. $4.

Two up-to-date books for those who are interested in the financial side of railroading. "Railway Accounting Procedure" deals with the technicalities of railroad accounting, now largely standardized by the requirements of the Interstate Commerce Commission. "Analysis of Railroad Operation" on the other hand is a sort of guide book for those who are not railroad accountants but who must analyze their reports in order to determine whether the operations of the railroads are a financial success or not

Transportation of Freight

FREIGHT TERMINALS AND TRAINS—By John A. Droege, General Manager, N. Y., N. H. and H. R.R. Co. Second Edition. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6 x 9 in.; pp. 567; 232 line cuts and halftones. $6.

Rapid developments in the field of freight-train operation since the first edition of this book was published in 1912—which book replaced and enlarged upon its predecessor, "Yards and Terminals"—have necessitated an entire revision and enlargement. The whole field of freight transportation is covered, including the design and operation of terminal yards and facilities, freight houses, team tracks, engine houses, and coal- and ore-handling yards and equipment, as well as the more personal side of freight transportation, the handling of the men who operate the trains and auxiliary facilities. New chapters have been added to deal with two subjects which have increased greatly in importance since the earlier edition was published, the use of electricity in main-line operation and in switching service, and the use of motor trucks as a supplement to freight trains. Both are timely subjects which add to the value of the book.

PUBLICATIONS RECEIVED

A BOOKLET entitled "Seventy-five Years of Gas Service in Chicago," written by Wallace Rice, has been issued by the Peoples Gas Light & Coke Co. of that city.

UNIVERSAL METERING IN CHICAGO, as reported on a few months ago by Maury & Gordon (Monadnock Block, Chicago), is now available in the form of a reprint from *Engineering & Contracting*.

A BRIDGE DEPARTMENT MANUAL, for field use of its bridge department, has been issued by the California Highway Commission (Sacramento). R. M. Martin is state highway engineer, and Harlan D. Miller is bridge engineer.

EARTH AND GRAVEL ROAD ARTICLES published since 1920 are listed in a bibliography compiled by the Engineering Societies' Library, 29 West 39th St., New York City, and sold for $1.50 a copy. 141 articles are listed.

A CITY PLANNING PRIMER, designed especially to meet conditions in Indiana, has been prepared by G. E. Lommel, Associate Professor of Topographical Engineering, Purdue University, and Frank G. Bates, Professor of Political Science, Indiana University, and has been issued as a bulletin of the Engineering Extension Service of Purdue University (Lafayette, Ind.).

RECENT TECHNOLOGIC PAPERS of the Bureau of Standards (Washington, D. C.) are Tests of Hollow Tile and Concrete Slabs Reinforced in One Direction, by Douglas E. Parsons and Ambrose H. Stang, and Relation Between Heating Value of Gas and Its Usefulness to the Consumer, a Critical Review of the Published Data, by E. R. Weaver. (From Superintendent of Documents, Washington, D. C., for 25 p. and 30 p., respectively).

FARMERS BULLETINS entitled Simple Plumbing Repairs in the Home, Farm Plumbing, and Farmstead Water Supply may be had on application to the United States Department of Agriculture, Washington, D. C. Another bulletin in the same series, Growing and Planting Coniferous Trees on the Farm, is also presumably available to applicants, one copy each, while additional copies can be had at ten cents each from Superintendent of Documents, Washington, D. C.

A VITAL PROBLEM in dealing with concrete is gone into in Studies of Curing Concrete in a Semi-arid Climate, a 37-p. bulletin written by Harrison F. Gonnerman, associate engineer, Structural Materials Research Laboratory, and C. L. McKesson, materials and research engineer, California Highway Commission. Tests made in Sacramento through the co-operation of the California Highway Commission and Structural Materials Research Laboratory, are presented. The bulletin is published by the Laboratory mentioned (Chicago, Ill.).

LARGELY INCREASED use of creosoted pine poles is indicated in a 36-p. 6x9-in. pamphlet on Quantity of Wood Treated and Preservatives Used in the U. S. in 1924, compiled by R. K. Helphenstine, Jr., of the U. S. Forest Service in co-operation with the American Wood Preservers Association. The number of poles treated in 1924 was 899,201 compared with 451,852 in 1923. All other classes except wood blocks showed increases in 1924 over the previous year. The pamphlet may be obtained from the Forest Products Laboratory, Madison, Wis., or the Service Bureau, American Wood Preservers Association, Chicago.

AMONG THE REPRINTS from various journals that constitute volume 5 (1924) of Contributions from the Anna M. R. Lauder Department of Public Health, Yale University, School of Medicine (New Haven, Conn.) are: The Organization and Budget of a Health Department for a City of 20,000 population, by Ira V. Hiscock, from the *American Journal of Public Health;* and Tuberculosis Mortality in Relation to the Pasteurization of Municipal Milk Supplies, by C.-E. A. Winslow and Cora E. Gray, from the *American Review of Tuberculosis*. Another reprint deals with milk pasteurization and two with other aspects of public milk supplies.

New Books and Revised Editions

[*Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.*]

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS' GUIDE, 1925-1926, Containing Design and Specification Data Useful in the Planning and Construction of Modern Heating and Ventilating Installations; Prepared from the Society's Transactions, Investigations of Its Research Laboratory and the Practice of Its Members; Together with a Manufacturers' Catalog Data Section Containing Essential and Reliable Facts Concerning Modern Equipment; and a Consulting Service Section for Engineers; also The Roll of Membership of the Society. Volume 4. Published Annually. New York: American Society of Heating and Ventilating Engineers. Cloth; 6 x 9 in.; pp. 574; illustrated. $3.

AN INTRODUCTION TO THE METHODS OF ECONOMIC STATISTICS—By William Leonard Crum, Assistant Professor of Statistics in Harvard College, Director of the Statistical Laboratory of the Harvard University Committee on Economic Research; and Alson Currie Patton, Actuarial Department, Phoenix Mutual Life Insurance Co., formerly Instructor in Statistics, Yale University. Chicago and New York: A. W. Shaw Co. Flexible; 6 x 9 in.; pp. 493; 147 charts, many tables, bibliography, logarithms. $6.

DRAINAGE AND FLOOD-CONTROL ENGINEERING—By George W. Pickels, C.E., Associate Professor of Drainage Engineering, University of Illinois, M. Am. Soc. C.E., M.A.S.T.M., M. Ill. Soc. Engrs., M. National Drainage Congress. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6 x 9 in.; pp. 450; 154 halftones and line cuts. $4.

ECONOMIC GEOLOGY—By H. Ries, A.M., Ph.D., Professor of Geology at Cornell University. Fifth Edition, Revised. New York: John Wiley & Sons; London: Chapman & Hall, Ltd. Cloth; 6 x 9 in.; pp. 843; line cuts and halftones. $5.

The aim of the author in the fifth edition of this book has been "to make such changes in subject matter and statistical figures as would bring the book up to date without increasing its size." The first edition was reviewed in *Engineering News*, Jan. 1, 1906, by the late Dean N. S. Shaler, and the second edition was noted Nov. 17, 1910.

DE HEDENDAAGSCHE STAND VAN HET VRAAG STUK DER ZUIVERING VAN HUISHOUDELIJK EN INDUSTRIEEL AFVALWATER—Door Dr. Jan Smit, Privaat-Docent in de Microbiologie aan de Universiteit van Amsterdam. Rotterdam (Holland): Nijgh & Van Ditmars Uitgevers-Maatschappij. Paper; 9 x 12 in.; pp. 170; 27 halftones and line cuts, and a section of 21 plates showing many halftones and charts.

A review (in Dutch) of the present state of the treatment of sewage and industrial wastes, including the activated-sludge process, disinfection of effluents and disposal of sludge. Some 300 references to European and American literature and some halftones are presented.

NIAGARA IN POLITICS: A Critical Account of the Ontario Hydro-Electric Commission—By James Mavor, Emeritus Professor of Political Economy in the University of Toronto; Author of "An Economic History of Russia," etc. New York: E. P. Dutton & Co. Cloth; 5 x 8 in.; pp. 255. $2.

ÜBER QUERPROFILE VON BINNENSCHIFFAHRTSKANÄLEN—Von Dr.-Ing. Paul Schmies. Berlin: Julius Springer. Paper; 7x10 in.; pp. 57; 51 line cuts and halftones, 4 tables.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Pompeiians Laid Water Mains on Both Sides of the Street

Sir—Your query as to laying water mains on both sides of the street reached San Francisco just after I had left for a trip to Europe. I would like to add to the reports of practice and opinion on this subject that were published in your issues of Aug. 27, Sept. 24 and Oct. 15, that I believe it is very wise to have mains on each side of the streets and save cross cutting wide streets with long unsightly trenches. I just came from Italy and in Pompeii 2,000 years ago they had their little dinky lead mains 2 and 3 in. in diameter laid in the little narrow sidewalks. So there is nothing new in keeping water mains close to the buildings.

M. M. O'SHAUGHNESSY,
City Engineer.

San Francisco, Calif.,
Oct. 24, 1925.

Four-Rod Roads Have Merits

Sir—In *Engineering News-Record*, Sept. 17, 1925, p. 453, you have an editorial, "Four-Rod Roads Going," relating to the modern tendency of widening roads in order to cope with the ever increasing amount of motor traffic to which they are subject. You make the observation, "In the curious origin of English units of measure there is perhaps an explanation of the choice of this odd width of 66 ft. for a highway, but today it has no logic apart from the claims of precedent and tradition."

The origin of some of the English units of measure is undoubtedly very curious, relating as they do to parts of the human body, or to such things as barley corns, dry and taken from the middle of the ear, or the aggregate length of the left feet of sixteen men, big and small, short and tall, as they come out of church on a Sunday morning, etc. (see The New International Encyclopedia, under *Weights and Measures*). The acre, for instance, was first defined as the amount of land a yoke of oxen could plough in a day.

The use of the 66-ft. road where English standards of measure are employed is a direct result of the use of the Gunter's chain of this length. This chain was developed by Edmund Gunter (1581-1626), an English mathematician who gave to the world a number of most valuable mathematical inventions. The usefulness of this chain arose from the fact that it was divided into 100 links and also that 10 square chains make an acre, a testimonial to the value of decimal or centesimal division even in those days.

However awkward it might be to convert from one unit to another, it is undoubtedly true that such units arose through a real need of them at the time.

The Dominion lands system of survey by which the Canadian West is subdivided, and in fact a great part of the survey subdivision throughout Canada and, I believe, the United States, is laid out according to the units of chains and links.

In the years from 1867 to 1883 much of the southern part of Manitoba and a small part of Saskatchewan were subdivided by the Dominion lands surveys system, the regular width of the road allowances, placed at intervals of one mile each way, both north and south, and east and west, being one and one-half chains or 99 ft. It was felt, however, that too much land was given over to road allowances and in 1883 this was changed. In all further subdivision in the prairie provinces one-quarter of the road allowances were done away with and their width cut down to one chain or 66 ft.

The one chain wide road allowances in the latter townships have served their purpose very well and have with a few exceptions, been found quite ample up to the present day. The townships are six miles square and in each one is included 54 miles (very closely) or 432 acres of these regular road allowances. Of course, the Canadian West does not have the density of population of parts of the United States. It would be very difficult to prophesy just when these roads, on the whole, will have reached their saturation point, so far as motor traffic is concerned. Perhaps long before such a state of things becomes possible, aerial transportation will be the thing and the pressing problems will be those of aerial traffic regulations and landing fields rather than of roadways. Who knows?

For the immediate future and for many years to come, therefore, we may look forward, in the Canadian West at least, to the necessity of widening roads along trunk lines only. In a township six miles square it may be assumed that very seldom will there be more than twelve miles of such trunk roads required. To widen these twelve miles of roadway from 66 ft. to, say, 99 ft. would require an addition 48 acres in each township. To widen all the 54 miles of road allowances in a township to 99 ft. would require an additional 216 acres in each township.

The problem then, so far as motor traffic in the Canadian West is concerned, resolves itself into something like this: Is it better to lay out this extra 216 acres in each township at the time of the original survey is made and keep it idle, unproductive and a constant menace in the spread of noxious weeds, on the chance that some of it will be required on account of motor traffic, or is it better to buy up the additional 48 acres required for trunk roads as needed. The problem is similar in other parts of the country, the difference being one of degree.

This treats the problem from a point of view of motor traffic considerations only. There may, of course, be other reasons for widening roads as, for instance, esthetic considerations, the planting of trees, the laying out of bridle paths, etc., but these cases should each be treated on its own merits.

F. H. PETERS,
Director of Topographical Survey of Canada.

Ottawa, Ont.,
Oct. 23, 1925.

Laying and Jointing Sewer Pipe in Russia

Sir—I have read with interest the article by A. G. Dalzell on "Points in the Design and Construction of Pipe Sewers," in your issue of July 2, p. 20. How important careful backfilling is, I found illustrated in Orenbourg, Russia, where I was engaged in 1918 on reconstruction of the city sewers completed the year before. The work had been carried out late in the fall and part of the backfilling had been done with frozen earth. As the result of such practice about two miles of 18 to 30-in. sewers were smashed the next spring by the settling fill. I had to reconstruct also several lines of pipes which generally stood up well but leaked to some extent.

I cannot agree with Mr. Dalzell's statement that with the bell of a pipe in a hole the making of a good joint in the bottom of the pipe cannot be properly done in wet ground. With cheap labor, as it was in Russia, one may obtain very satisfactory results. All pipes used there were of the bell-and-spigot type up to 24-in. When replacing the pipes or tightening the joints of formerly laid sewers, bell holes were dug. After the joint had been packed with bituminous material and a tarred rope of 0.75 to 1 in. had been slung around the pipe close to the bell, the bell hole was filled by hand with stiff clay up to half of the height of the pipe, thus avoiding the formation of a reservoir of damp earth underneath the joint. Then the rope was carefully pulled out and elastic jointing material poured in the hole. The upper part of the joint was also covered with clay. In wet ground the whole lower half of the pipe was embedded in clay and the upper one often got a covering of about 3 in. of concrete. Thus laid, sewers always stool well the water pressure test and repeated careful inspection with drained out sewers with very few exceptions showed good alignment and no signs of leakage, even with an external ground water pressure up to 5 feet.

H. A. SEYDENBACH,
City Engineer.

Tartu, Esthonia,
Nov. 1, 1925.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Engineering Council to Act on Many Subjects

To Study Regulation of Utilities, Government Reorganization and Civil Aviation

The administrative board of the American Engineering Council, meeting at Columbus, Ohio, Oct. 29 and 30, authorized the appointment of a committee to review and analyze the Pennsylvania Giant Power report. The board's action followed representations that the Giant Power report contains economic fallacies likely to mislead the public. The aim of the analysis is to provide a popular interpretation of the report from an engineering standpoint.

Plans contemplating a nationwide study of public utilities were set in motion by the board, which voted to appoint a committee to determine a definite scheme of investigation and report to the council at its annual meeting in Washington early in January. Questions confronting the engineers, should the council decide to undertake the study, involve where federal regulation should end and municipal regulation begin; what should be the policy with reference to regulation of super-power systems; whether methods of regulation should be written into state constitutions; theories of valuation; theories of rate making, and the standards of service required by federal and state commissions.

Civil Aviation

The board adopted the report of the joint committee on civil aviation of the council and the Department of Commerce. The report assembles data gathered in this and other countries and contains definite recommendations upon which a national program of commercial flying may be predicated.

The board voted to press the council's effort in the field of U. S. Government reorganization, and authorized the presentation at the next session of Congress of a bill establishing a Division of Public Works in the Department of the Interior.

"The American Society of Mechanical Engineers," executive secretary Wallace reported to the Board, "has been requested to appoint a special committee to review the assembled information and on the basis thereof develop a functionalized organized plan for the proposed Division of Public Works.

"The study being made will be a most important contribution to the argument in favor of a Division of Public Works. It will show the inefficiencies and duplications now existing and the improvements that may be expected under a corrected functionalized organization."

The board adopted a resolution to introduce in Congress a bill providing for an inventory of the water resources of the United States. This inventory would be entrusted to the Geological Survey and would be completed within twenty years. Evidence to show a widespread demand among engineering organizations for this work was presented by the executive secretary.

Efforts to accomplish effective results in reforestation through co-operation between the states and the Federal government under the Clarke-McNary act will be continued by the council.

Engineering Fifty Years Ago

From *Engineering News*, November, 1875

By Hook or Crook

THE PHRASE "By hook or crook" originated in London more than 200 years ago after one of the greatest conflagrations we have any record of, and which swept over that city reducing its greatest portion to ruins and utterly destroying old land marks. Many disputes arising concerning the location of the lines between lots. To effect a satisfactory settlement, arbitrators were selected with the customary understanding that their decision should be final. The names of the surveyors in whom this confidence was reposed as the parties affording the most renowned satisfaction, were the Messrs. Hook & Crook, and it was their decisions and their universal approbation, which gained for them so great a notoriety that their boundary lines, so established, became defined as "By Hook & Crook."

W. E. P.
Lakeville, Conn.

Highway Work in Tennessee

The department of highways of the state of Tennessee is calling for bids on two and one half million dollars worth of highway construction and bridge work. This is the largest single letting the state has ever had.

Steelwork Contract Let for Buffalo-Fort Erie Bridge

Contract for the steelwork for the bridge now under construction across the Niagara River between Buffalo and Fort Erie has been let to the Bethlehem Steel Co., the low bidder, for an amount stated to be $1,324,750.

Mokelumne Water Case Before Commission

Decision Expected in February in Case Affecting Water Supply of East Bay Cities

Testimony has been completed in the hearings at Sacramento before the California state division of water rights and the federal power commission in the case of the Mokelumne River, proposed as a source of water supply for the East Bay cities. The hearings started Sept. 11, were completed Oct. 23, applicants were given until Jan. 5 next to file final briefs and a decision is expected probably some time in February. Edward Hyatt, Jr., chief of the division of water rights, presided and with him were F. E. Bonner and E. W. Kramer, representing the federal power commission. Previous reference to the discovery and proposed development of the two reservoir sites and the $39,000,000 bond issue appeared in *Engineering News-Record*, Oct. 2, 1924, p. 559, and Dec. 11, 1924, p. 961, and Oct. 8, p. 608.

Various Claims

The first claims to the Mokelumne waters in question are held by J. W. Preston, Jr. whose applications, of which some are already granted, were primarily for power and secondarily for irrigation. These applications do not necessarily interfere with the principal contest in the case which is with respect to the Lancha Plana reservoir site as a source of domestic supply.

First claims to the Lancha Plana site are held by the Kieffer interests with whom is associated C. W. Landis who has worked out plans for developing both domestic and irrigation supplies under a program calculated to be acceptable to all water users below. Based on a comprehensive development plan the Kieffer interests, when the East Bay municipal utility district recently called for bids on the Mokelumne water supply, put in a bid of $29,000,000 for which they offered to deliver a water supply system as a completed project including all responsibility for settling with objectors and other claimants to these waters.

This offer was not accepted, the district electing to award contracts independently of the Kieffer filings and to follow up its own later filings on the same waters. The district asks for a permit to develop the desired storage under the state law that gives municipalities a priority over filings made earlier by private individuals or corporations.

Pending the outcome of the case before the water commission the municipal utility district has definitely awarded contracts for building a pipe

(*Continued on p. 851*)

Ira Osborn Baker

Sept. 23, 1853—Nov. 8, 1925

An Appreciation by Prof. C. C. Williams, Head of Department of Civil Engineering, University of Illinois

In the death of Dr. Ira Osborn Baker, professor emeritus of civil engineering at the University of Illinois, the civil engineering profession has lost a distinguished intellectual leader; the educational world, a teacher with power and inspiration, an administrator with vision and courage; and many have lost a loyal and lovable friend.

Professor Baker's fifty-one years on the faculty at the University of Illinois constituted an unusual privilege and a great opportunity. Spanning the formative period of engineering education (1874-1925), he saw engineering education develop from the pioneer stage to its present form, and in that development he played a conspicuous part.

Professor Baker was a product of the Middle West. Born at Linton, Indiana, but moving early to central Illinois, he was educated at Mattoon high school and the University of Illinois. He graduated from the latter in civil engineering in June, 1874, was given the degree of C.E. in 1877 and Dr. Eng. in 1903. His high scholarship caused him to be appointed as assistant in civil engineering and physics in September following his graduation. In 1879 he was made assistant professor and in 1880 professor of civil engineering. He continued in charge until 1915 when he retired from the headship but continued as a regular professor until 1920. In that year he was called to become acting head of the department, continuing in that capacity until September, 1922. After the latter date, he taught one graduate course in highway engineering until the time of his death.

In the earlier years, Professor Baker gave instruction in a diversity of subjects including physics, mechanics, and astronomy in addition to those in the civil engineering curriculum. In many of the latter there were no satisfactory textbooks available, and Professor Baker prepared a number of textbooks by writing out the text on tracing paper and blueprinting the needed copies. Typewriters were unknown and blueprinting was a novel process at that time. Some of these "home-made" texts ripened into standard treatises later, such as "A Treatise on Masonry Construction," "An Engineer's Surveying Instruments" and "Roads and Pavements." The first of these which appeared in 1889 is the best known of his writings. Its reception and use were immediate and extensive. It was given high commendation by the technical press at home and abroad, was almost universally adopted as a text book in engineering colleges and was used by practicing engineers all over the world.

Dr. Baker was an early investigator in the properties of brick, cement and concrete. His tabulation of the bearing capacities of various soils was probably the most complete up to that time and has had a wide influence on construction everywhere.

Professor Baker exerted a notable influence on highway engineering and policies, both state and national. His conservative views of the economics of highways placed him on intermediate ground between the extremists on the one hand who made extravagant claims for improved highways and who advocated building regardless of the tax burden and those on the other hand who contended that agricultural regions could not support any improved highways. In the press and on the platform, he laid his arguments before the public, with the result that his opinions are a part of the fabric of the highway policies of the present time.

Dr. Baker's great service to the profession was as a teacher. To him teaching meant training of intellectual powers during normal growth rather than the acquisition of vocational knowledge and dexterity. In subject matter he steered a median course between the so-called practical education on the one hand and the intensely theoretical on the other. A ready and interesting speaker, with an excellent command of language, apt in his illustrations, with a pleasing manner and rare personal charm, careful in the preparation of his subject matter, and with an unusual facility in systematic outline, his classes were both inspiring and illuminating. Never oversevere, yet exacting in quality of work, his instruction was productive of logical and comprehensive thinking. His own indefatigable industry and punctuality induced like characteristics in his students wherever the germs of such traits were latent. His own stainless personal life and devotion to family constituted a living lesson on fidelity. His community activity as a devout and reverent Christian gave emphasis in the student's thought to the importance of religious growth in the rounded man. By precept and example, above and back of the technical subjects of the curriculum, he taught young men the qualities of manhood which are so essential to the engineer as well as to the successful practice of any other vocation. Like a sculptor at his work, he kept a clear vision of his ideal as he molded the plastic youth of his students.

Professor Baker's professional activities were not limited to the campus. He served as advisor of public officials in connection with highway bridges, drainage, pavements and building codes. That he saved the counties of Illinois many thousand dollars by his expert services is the written testimony of county supervisors.

In the broad affairs of the profession he always took an active part. A member of the American Society of Civil Engineers for over 30 years he had served on its committees and participated in its deliberations. He became a member of the Western Society of Engineers in 1886 and was twice elected to office. He founded the Illinois Society of Engineers in 1886 and was always active in directing its destinies. To him is generally given credit for conceiving and organizing the Society for the Promotion of Engineering Education because it was due to his efforts that a Division of Engineering Education was provided at the World's Columbian Exposition in Chicago in 1893. He was chairman of the committee on arrangements, secured the program and presided at its sessions. From this gathering, the S. P. E. E. was organized and the proceedings of this Division of Engineering were printed as Vol. I of the Proceedings of the S. P. E. E. He was always active in the work of this society and was again its president in 1899-1900.

In the passing of Professor Baker, another of the pioneers in engineering education leaves the stage, and the profession loses an illustrious exemplar of its best ideals.

Harrisburg Bridge Reconstruction to Cost $1,500,000

The directors of the Harrisburg Bridge Co. on Oct. 20 awarded a contract for reconstruction of the Market St. bridge over the Susquehanna River at Harrisburg, Pa., to the James McGraw Co., Philadelphia. The cost of the work will approximate $1,500,000, depending upon the class and character of the stone to be used in the construction of the stone arches, which has not been decided upon at this time.

An island divides the river into two channels at the Market St. crossing. The existing bridge consists of 16 steel girder spans over each channel, and has a roadway 18 ft. wide. The work of reconstruction will consist of removing the spans from the east channel and, after lengthening the piers, placing them alongside the existing spans on the west channel, thus doubling the capacity of the west channel bridge by giving two parallel structures over that channel similar to the present bridge. A new stone-faced arch bridge will be built over the east channel.

The bridge is a toll bridge, owned by the Harrisburg Bridge Co., which will finance the reconstruction. Ralph Modjeski and Frank M. Masters are the engineers for the work.

More States Asked to Join in Tri-State Power Survey

The States of Maryland, West Virginia, and Ohio have been invited to name representatives to serve with the recently appointed Joint Power Commission of the States of New York, Pennsylvania and New Jersey. These representatives are to act as observers and advisers in the preparation of legislation for the control of power in interstate movements which is to be prepared by the joint commission. It is expected that the States of Delaware, Connecticut, Massachusetts, and Virginia also will be asked to send representatives to sit with the joint commission.

Bridge River to Be Developed By Power Company

Announcement has recently been made by George Kidd, president of the British Columbia Electric Co. that his company has taken over the Bridge River power site and will begin construction in 1927. This decision was reached as the result of investigations recently under way reported in *Engineering News-Record*, Aug. 27, p. 362.

The Bridge River project is one of the larger in the northwest. The ultimate continuous capacity at 75 per cent load factor is estimated at 410,000 hp. and the ultimate installed capacity will probably be 700,000 hp. Development will take place in five stages, the first being the installation of 54,000 hp. As the demand increase the height of the dam will be increased and additional storage provided as shown in the accompanying table.

The Bridge River power project was first staked about 15 years ago and was for many years in the hands of W. R. Bonnycastle, consulting engineer, Vancouver. Recently the project has been handled by a Montreal syndicate known as the Bridge River Power Co. For the last year and a half the B. C. Electric Ry. Co. has held an option on the property and water rights and has been making exhaustive investigations, with field work under the direction of Mr. Bonnycastle. The whole plan was reported upon by J. D. Galloway, consulting engineer, San Francisco, and details of Mr. Galloway's plans have been worked out by E. E. Carpenter, the power company's consulting engineer.

The power site is about 135 miles from Vancouver, at a point where Bridge River comes within 2½ miles of Seton Lake at an elevation about 1,200 ft. above it. In general, the plan is to drive a tunnel 12,800 ft. long which would bring Bridge River water to the top of a 2,800-ft. penstock leading down to a power house on Seton Lake. Transportation problems will be simplified by the fact that the Pacific Great Eastern Ry. is now in operation past the power house site. The first dam would be for diversion purposes only and would have an initial height of 80 ft. with provision for ultimately raising it to 160 ft. Other dams would later be built for storing water at points farther up on the Bridge River basin. The transmission line is to be designed for 165,000 volts, and would come to Vancouver via the route of the Pacific Great Eastern Ry. to Squamish and thence along Howe Sound. Additional lines will be built as required.

SUMMARY OF BRIDGE RIVER DEVELOPMENT

Bridge River Project	First Stage	Second Stage	Third Stage	Fourth Stage	Fifth Stage	Ultimate
Number of units installed	2	3	5	7	9	
Total installed capacity	45,000 kva. 54,000 hp.	67,500 kva. 81,000 hp.	112,500 kva. 135,000 hp.	157,500 kva. 189,000 hp.	202,500 kva. 243,000 hp.	458,000 kva. to 584,000 kva. *550,000 hp. to 700,000 hp.
Continuous capacity at 75% load factor	29,300 kw. 40,500 hp.	44,000 kw. 60,750 hp.	73,300 kw. 101,250 hp.	102,600 kw. 141,750 hp.	131,900 kw. 182,250 hp.	296,700 kw. 410,000 hp.
Water required — continuous flow	350 sec.-ft.	530 sec.-ft.	860 sec.-ft.	1,210 sec.-ft.	1,560 sec.-ft.	3,500 sec.-ft.
Storage	50,000 acre-ft. 80-ft. Diversion Dam	50,000 acre-ft. 80-ft. Diversion Dam	500,000 acre-ft. 160-ft. Diversion Dam	500,000 acre-ft. 160-ft. Diversion Dam	500,000 acre-ft. 160-ft. Diversion Dam	1,700,000 acre-ft. 160-ft. Diversion Dam 230-ft. LaJoie Dam. Other Upper River Storage
Transmission line circuits at 165,000 volts	1	1	2	2	3	6

* Depending on System Load Factor.

WASHINGTON NOTES

THE action of the Federal Power Commission in suspending consideration of all applications on the Colorado river and its tributaries, applies just as effectively to the Boûlder Canyon project, it is pointed out, as it does to that of J. B. Girand at Diamond Creek.

The question also has been raised as to whether the commission did not exceed its authority in suspending the operation of an act of Congress, particularly when the purpose involved was distribution of water among states—a matter over which the commission has no authority.

It was revealed recently that the commission, when it adopted its resolution suspending consideration of the Colorado basin applications went further as a matter of moral obligation and guaranteed a very definite priority to Mr. Girand. The text of the formal resolution which grants this priority reads as follows:

"Whereas, the Federal Power Commission has refused for the time being the application of J. B. Girand, together with other applications for power projects upon the Colorado River system, in order to give the states of the Colorado River basin further opportunity to reach an agreement among themselves as to a division of the waters of the river system; and

"Whereas, said Girand has been given encouragement by the Federal Power Commission and predecessor agencies or departments of the Government during the past twelve years which has influenced him in the expenditure of considerable money in anticipation of a license;

"Resolved: That when the present policy of temporary suspension of action on all applications for licenses on the river is changed, and licenses may issue on the Colorado River, then the Girand application should be given a preferred consideration for license at Diamond Creek."

DESPITE the attention being given to alternate reorganization plans President Coolidge continues to give his undivided support to the original plan developed by the Brown commission, as altered by the Congressional committee. This plan is set forth in the legislation known as the Smoot reorganization bill, which was not taken up at the last session. It will be reintroduced at the coming session without change. The bill is slated for early consideration, but probably will not be pressed for passage until ample time for debate and investigation has been allowed.

In the aggregate the opposition to the bill is formidable. The general impression on Capitol Hill is that it cannot pass. This accounts for the reliance which administration leaders are placing in an alternative proposal, which will be presented if the Smoot bill fails, vesting the President with power to transfer bureaus.

THE Federal Power Commission has authorized the issuance of a joint license to the Feather River Power Co. and the Great Western Power Co. covering a large project on tributaries of the North Fork of Feather River in Plumas County, Calif. The license, however, is to be contingent on the securing of the necessary state rights and upon the commission being given the right to have access to all books and records of the companies so that nothing in excess of the actual ligitimate cost of the project may be entered upon the project account. It is proposed to erect a dam 106 ft. high to create a reservoir with 103,000 acre-feet of storage. The water is to be conducted to a power house on the North Fork of the Feather River, where equipment sufficient to generate 60,000 hp. will be installed.

World's Largest Auditorium for Atlantic City

Plans for the largest auditorium in the world to be built at Atlantic City, N. J., are being rushed in order that bids on the work can be called for by the first of the year in order to have the foundation completed by spring and the building completed in 1927. The building will be 350 ft. wide by 650 ft. deep, will have 168,000 sq.ft. of floor area in the main auditorium and an additional space of 100,000 sq.ft. on the ground floor. The main auditorium will have a capacity of 30,000 on the floor and 10,000 in the balcony, giving a total of 40,000. The clear span over the main auditorium will be 350 ft. and the height from the auditorium floor to the bottom of the trusses 115 ft. clear. There will be a large hall in the front of the building with a seating capacity of 3,000 including the stage. The building will be of fireproof construction throughout with a facing of limestone and marble on the boardwalk frontage and a light colored brick for the other exterior walls. Lockwood, Greene & Co. are the engineers and architects.

Seaboard Railroad Construction Plan Approved

The plan of the Seaboard Air Line Railway Co. for the formation of a new railroad system in Florida to be known as the Seaboard-All Florida Railway Co. through the acquisition and construction of railroad lines in Florida, has been approved by the Interstate Commerce Commission. Details of the plan were given in our issue of September 3, page 399. The principal items of the construction under that program are as follows: (a) From a connection with the Florida, Western & Northern at West Palm Beach to Miami and Florida City, a distance of approximately 100 miles; (b) from a point near Fort Ogden on the Charlotte Harbor & Northern Ry. to Fort Myers, approximately 36 miles; (c) from Fort Myers to the south bank of the Estero River, approximately 14 miles to connect with the proposed Naples, Seaboard & Gulf Ry.; (d) from Fort Myers to a point on the Caloosahatches River in the direction of Labelle, 33 miles; and (e) from a point on the Fort Myers-Estero line to Punta Rassa, a distance of 11 miles.

Failure of citizens of Miami to provide land for right-of-way may stop construction of the first line, according to a recent announcement. The railroad was induced to build into Miami by the offer of land for a right-of-way after speculators had blocked its plans.

Mokelumne River Water Case Before Commission

(*Concluded from p. 851*)

line as far as the San Joaquin River where an emergency supply could be secured, and also provisional contracts for construction further up toward the Mokelumne source, these to become effective if the decision in the application for water rights is favorable to the district.

In addition to the issue between the original claimants and the East Bay district there are questions of the effect of any Mokelumne development on the salt water content in the lower Sacramento and San Joaquin Rivers. Also the question of how such development will affect the ground waters from which extensive areas along the lower Mokelumne pump water for irrigation. Interests affected by these questions were represented at the hearings.

The Lancha Plana reservoir would require a 350-ft. concrete dam on the Mokelumne River, creating a storage of 222,000 acre-ft. from which surplus water would flow over into the adjoining Arroyo Seco reservoir. The latter, with a capacity of about 1,000,000 acre-ft. could be developed by the construction of an earth dam about 1,800 ft. long and 125 ft. high. By developing these two sites in conjunction, a large storage basin in Dry Creek could be used for surplus Mokelumne flow which could not be stored in the Mokelumne Basin, thus supplying water to fill the large Dry Creek reservoir that could not be filled from its own drainage basin.

Power Company Renames Plant to Honor Engineer

The Southern Sierras Power Co. of Riverside, Calif., has, by resolution at a special meeting of the board of directors, changed the name of one of its power plants to honor the late C. O. Poole, chief engineer of the company. The main part of the resolution declares, "that hereafter the Leevining Creek No. 1 plant shall be designated the Poole plant in recognition of the engineering skill and invaluable services rendered our associated companies by the late Charles Oscar Poole."

New York Central Electrification Plans Approved

Plans for the electrification of the West Side tracks of the New York Central Railroad Co. on Manhattan Island as required by the Kaufman Act (New York) have been approved by the New York State Public Service Commission. Third-rail electrification similar to that in use on the main line above Spuyten Duyvil will be used where the railroad operates on its own right-of-way from Spuyten Duyvil to the 72nd St. yards and below that point oil-electric locomotives will be used. Below 72nd St. the railroad operates across and along numerous streets and avenues and no form of direct electrification is considered practical or possible until the matter of grade separation has been determined. Oil-electric locomotives of the type to be used have been used experimentally and found satisfactory. One of these locomotives was described in our issue of Sept. 4, 1924, p. 390. It was then in this service. Such locomotives are practically noiseless and give off no objectionable smoke or gases.

Construction Projects and Bond Issues Approved Recently

Further details on bond issues and other items of engineering interest approved at the recent election in addition to those given in last week's issue, p. 813.

The people of Oswego, N. Y., approved of a proposition to develop approximately 7,000 hp. of hydro-electric energy at Dam No. 6 on the Oswego branch of the Barge Canal, at an estimated cost of $850,000. The plan calls for the leasing of the proposed plant for a period of 25 years. An alternative proposition to both develop and operate a plant of 3,000 hp. at the same site was rejected.

Sikeston, Mo., at a referendum held Oct. 20, voted $82,000 for new sewers and Fulton, Ky., voted $70,000 for sewers and accessories.

Pharr, Tex., approved a bond issue of $45,000 for a complete sanitary sewer system and $30,000 for a water-works system. Wichita Falls, Tex., approved a bond issue of $100,000 for street paving, and Dublin, Tex., will issue $40,000 worth of bonds for the same purpose. Gatesville also will issue $45,000 in bonds for street paving and improvement.

Towns and counties in Ohio voted nearly $1,000,000 for the construction of schools, the larger items being $150,000 at Spencerville, $125,000 at Newtown, $85,000 in Benter township, $70,000 in Marion County, $70,000 at Brunswick, and $60,000 each at Canal Fulton, Florida, and Marlboro township.

At a special election on Nov. 10 a $9,600,000 bond issue for harbor improvements at Oakland, Calif., was carried by a majority of 8 to 1. The improvements to be built under this bond issue, recommended by a board of engineers employed by the city, include wharves, docks, warehouses and other structures at several points along the bay frontage and in the estuary.

Random Lines

There Are Now 168 Varieties By Actual Count

(163-4) *Science and Blasting Engineer*—H. P. Rygaard, Sawtelle, Calif.

(165) *Dansant Engineers* — The Green Mill Amusement Co., who are also "feature arrangers" and "orchestra bookers," of Columbus, Ohio.

(166) *Furnishing Engineer*—James M. Cox, of Utica, N. Y. Is he the fellow who ran for president or something here awhile ago?

(167) *Dry Cleaning Engineers*—"Cooney's," of Waterbury, Conn. Gets in because of the "Dry." There have been a lot of plain "cleaning engineers" already entered.

(168) *Container Engineers*—In the Buyers Classified Guide of a contemporary "Barrel & Box." Two firms are listed.

* * *

Why There Are So Few Lady Engineers

"Permission was granted a young woman, Helen Fursman, of Bromide, Okla., to enter the civil engineering department of the University of Texas this year. This is the first time in 20 years a woman has been accepted by the University in that department.

"There were two main reasons for this. First, the clothing worn by the young ladies, and, second, the bashfulness of the instructors. To explain in more detail: In 1905 two girls were enrolled in the department. They took a hiking trip with the instruments, but somehow the instruments would not work correctly when the girls were about. The instructor said he had often heard girls had magnetism, but he never knew they had enough to affect the compass needle. They claimed it was not them at all, but when they would withdraw far enough the instruments were again reliable.

"Further investigation caused the instructor, blushingly, to inform the girls that their corset stays were causing the trouble.

"The girls of 1925 don't have any effect on a compass."

—St. Louis *Post-Dispatch.*

Engineering Societies

Calendar

Annual Meetings

HIGHWAY RESEARCH BOARD, NATIONAL RESEARCH COUNCIL, Washington, D. C., Annual Meeting of the Highway Research Board, Washington, D. C., Dec. 3-4, 1925.

AMERICAN ROAD BUILDERS ASSOCIATION, New York City; Annual Convention, Chicago, Ill., Jan. 11-15, 1926.

AMERICAN ENGINEERING COUNCIL, Washington, D. C.; Annual Meeting, Washington, D. C., Jan. 14-15, 1926.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, Washington, D. C.; Annual Meeting, Portland, Ore., Jan. 18-23, 1926.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Meeting, New York City, Jan. 20-22, 1926.

ENGINEERING INSTITUTE OF CANADA, Montreal; Annual Meeting, Toronto, Ont., Jan. 27-29, 1926.

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Meeting, Chicago, Ill., Feb. 23-26, 1926.

The Thayer Society of Engineers (Thayer School of Civil Engineering, Dartmouth College) will meet at the Machinery Club, New York City, Jan. 19, 1926.

The Affiliated Technical Societies of Boston will hold a two-day meeting Dec. 10 and 11, discussing chiefly fuel and power, the subjects being: Sources and Utilization of Fuels, Requirements for Power in the Industries, and Operating Practice.

The Minnesota Section of the American Water Works Association held its fifteenth annual meeting Nov. 13 at the University of Minnesota. Papers were presented on hard water, algae treatment, posting highway wells, underground material and maintenance problems, the value and use of technical journals and a discussion by C. M. Crowley, chairman of the section, on the value of national organizations and state sections.

Personal Notes

E. F. KELLEY has been appointed chief of the Division of Tests and Research of the Bureau of Public Roads to succeed A. T. Goldbeck whose resignation to become director of the newly organized Bureau of Engineering of the National Crushed Stone Association was noted in our issue of Oct. 8, 1925, p. 609. Mr. Kelley has been associated with the bureau since 1920 on special work in connection with the standardization of bridge specifications, and since 1921 as chairman of the subcommittee on bridges and structures of the committee on standards of the American Association of State Highway Officials. Mr. Kelley was born at Latimer, Iowa, July 29, 1886, and was educated at the University of Minnesota and Iowa State College. He was with the American Bridge Co. for four years and with the Iowa State Highway Commission as assistant designing engineer and later as assistant bridge engineer. From 1919 until he went to the Bureau of Public Roads in 1920 he was with the Red Oak Bridge & Iron Works of Red Oak, Iowa.

R. R. POPE, recently resigned as resident engineer for the New Jersey State Highway Department in order to open and take charge of an office at 147 Albany St., New Brunswick, N. J., for the firm of Charles S. Sincerbreaux and G. Roland Moore, civil engineers, of Trenton, N. J.

CARLTON M. SOULE, formerly chief engineer of The Spencer Construction Co., and LEVIGNE M. ZEPP, formerly principal assistant engineer of Richard K. Meade & Co., consulting chemical and industrial engineers, announce their association for the practice of structural and mechanical engineering under the firm name of Soule and Zepp, Inc., with offices at 322 N. Charles St., Baltimore, Md.

OSKAR VON MILLER, engineer, of Munich, Germany, and government administrator of the German railways under the Dawes plan, was given a luncheon by representative engineers at Chicago on Nov. 9. Dr. von Miller is head of the railway museum at Munich and is visiting this country by invitation of a committee which is formulating plans for a national museum of engineering and industry. He has been prominent in hydro-electric development and in 1891 established the 102-mile 25,000-volt transmission line from Lauffen to Franfort, which was the first high-voltage line in Germany.

Obituary

WILLIAM D. JANNEY, Baltimore, Md., special engineer of the United Electric Rys. and Electric Co. of the city, died suddenly Oct. 30, aged 66 years. Mr. Janney was born in Baltimore; his engineering education was received at Lehigh University. His life was mainly spent in railroad work, the early part in surveys and construction, though he served at various times as chief engineer of three coal companies. Other work was on a section of Ohio River survey, general superintendent of construction of the Harbor Board, Baltimore, and private consulting practice from 1910 to 1919. In 1920 Mr. Janney became special engineer for the city railways of Baltimore.

GEORGE W. SUBLETTE, city engineer of Minneapolis, Minn., from 1899 to 1903, died suddenly Nov. 6 at his home in Minneapolis, at the age of 75 years. Mr. Sublette was born in Missouri and did early railroad work there. Also, in the Northwest he was identified with railroad work, construction for the Chicago & Northwestern and for the St. Paul, Minneapolis & Manitoba Ry. Before he became city engineer of Minneapolis, he had served on tunnel and sewer construction for the city.

HENRY C. IRONS, of Plainfield, N. J., head of Henry C. Irons & Sons, Inc., of New York City, contractors, died in Granby, Conn., after a short illness. Mr. Irons was in Connecticut engaged on the construction of the new office of the Connecticut Mutual Life Insurance Co. at Hartford. After the war he went to France as a consulting engineer in the reconstruction of the devastated regions. He graduated from Princeton University in 1889.

STANLEY KREBS, surveyor of St. Clair County, Ill., died in St. Louis, Mo., Nov. 4, in his 38th year.

VIRGIL G. MARANI, chief engineer, The Gypsum Industries, Chicago, died Nov. 2 at his home in Evanston, Ill. He was born in Reggio, Italy, in 1868 and was of titled ancestry. A graduate in 1893 of Toronto University, his first work was in charge of the Brantford (Ont.) sewage disposal and water works. From 1894 to 1896 he was assistant engineer in the Cleveland department of public works and from 1896 to 1907 chief engineer, Cleveland Gas, Light & Coke Co. Then for three years he entered private practice and was superintendent of the construction of a $5,000,000 courthouse and in the two years following was building commissioner of Cleveland. Since then he has been identified with the gypsum interests. Mr. Marani was the author of a model building code, numerous technical articles in *Engineering News-Record* and other magazines. He served with the British Merchant Marines from 1881 to 1888 as second officer, and was a representative on the War Service Committee on gypsum building, and secretary of committee C-11, American Society for Testing Materials.

JOHN REMSEN ONDERDONK, engineer of tests for the Baltimore & Ohio R.R., died suddenly at his office in Baltimore on Nov. 7. Mr. Onderdonk was a graduate of Stevens Institute of Technology. He entered the employ of the Baltimore & Ohio in 1890 as a draftsman. He soon was made an inspector and a number of years ago was appointed engineer of tests.

JAMES A. THOMPSON, pioneer contractor at Anderson, Ind., died recently at the age of 91 years. At one time he was superintendent of bridge construction for the Central Indiana R.R. and all his life had been affiliated with the contracting business.

HENRY B. GORHAM, of Devon, Conn., who retired two years ago as United States assistant engineer, died Nov. 5 at his home in Devon; he was 72 years of age and had seen forty years' service. Mr. Gorham had been construction engineer on breakwaters in Long Island Sound and on government projects around New York harbor.

From the Manufacturer's Point of View

A Point of Contact Between Maker and User of Construction Equipment and Materials

Expect 350 Exhibitors at Good Roads Show

Business Director Upham Predicts Breaking of All Records in Demands for Space

ALL records, both in number of exhibitors and attendance, will be broken at the Road Show in Chicago Jan. 11-15, according to predictions made to *Engineering News-Record* by Charles M. Upham, business director of the American Road Builders' Association.

"We have allotted space to 265 exhibitors," Mr. Upham reported on Nov. 14, "and have a list pending of 43. Each day there are one or two more new applicants, and I am sure that by the time the Road Show opens our list of applicants will have reached more than 350."

The amount of space available for Road Show exhibitors has been many times over-subscribed, and this year it has been found necessary to limit new exhibitors to balcony space, thus necessitating a number of changes in their exhibits as originally planned, due to restrictions on floor loading. The exhibits will be housed in the Coliseum, the Annex, the new Coliseum and the Greer Building, this being as much space as the association could obtain for the 1926 Road Show.

CONVENTION PROGRAM

This year the convention program of the American Road Builders' Association has been divided into two parts, one covering subjects of interest to highway engineers and officials and the other for highway contractors. The program, according to William H. Connell, president of the association, will include a number of controversial subjects, and topics that are claiming the attention of engineers and contractors throughout the country.

Simultaneously with its convention and show, the American Road Builders' Association is organizing "Good Roads Week" beginning Jan. 11. At this time civic clubs and good roads organizations throughout the country will feature special programs. In addition, a prize essay contest for college students has been announced. The subject is "A New Country by Improved Highways." Prizes amounting to $550 will be awarded and announced during "Good Roads Week" by radio from Chicago.

For the exhibits in the Coliseum, it is expected that the manufacturers will ship to Chicago 300 carloads of road-building equipment and materials.

Extensive Array of Equipment at All-Western Road Show

Road-construction equipment of all sorts with an aggregate value variously estimated from $2,000,000 to $3,000,000 was on display last week at the All-Western Road Show in San Francisco. Some 200 exhibitors participated, filling the five large circus tents and providing a generous overflow of exhibits for the fifty acres or more of outdoor space. Previous announcement of the show plans appeared in *Engineering News-Record*, Sept. 24, p. 528, and Oct. 28, p. 694.

The tents were a novel feature of the show that proved very popular. In addition to the space flexibility they afforded, the ground floor gave a freedom of movement for the heavy equipment and there was good ventilation permitting demonstration of exhibits that might not have been possible if the show had been housed in.

The tents covered an average area of 33,000 sq.ft. each and all of this space as well as the walks outside were carpeted with a thick layer of coarse sawdust. In the 37 acres under canvas many of the machines were demonstrated with electric power or with their own gasoline engines exhausting into pipes leading outside.

In the outdoor "proving ground" half a dozen gasoline shovels made excavations, sand scrapers dragged up material into "stock piles" and graders, trenchers and elevators of several types plowed or dug up great quantities of the earth fill that had been placed in 1915 to make the Panama Pacific Exposition site.

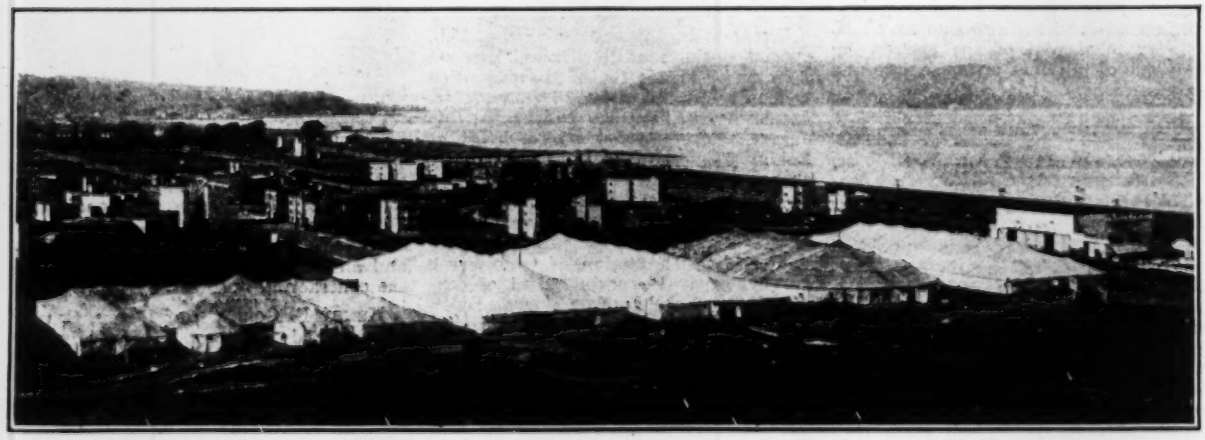
Still other exhibits of less bulky character were housed in a frame building used also for the Convention Hall. Each successive day was devoted to a different branch of the road-construction industry, as already announced, with one or more meetings including papers calculated to interest each particular branch. The "All-Western Roadeo," a newspaper devoted to the show, appeared daily and provided an attractive medium for announcements and other matters of interest to show visitors.

A number of manufacturers introduced novelties not before exhibited in the West, for example, a full-diesel shovel, new types of portable equipment, etc., and many companies displayed full lines of road-building machinery that gave the show a decidedly educational interest and rewarded those who had come some considerable distance to gather information.

Concrete Chuting Patents Held to Be Invalid

The Callahan patents as applied to the "Material Transferring Apparatus" do not possess the elements of distinctive inventive genius and hence use of the principle by others does not constitute infringement under the patent laws, the United States Supreme Court held Nov. 16 in affirming a decision of the Third Circuit Court of Appeals in the case of the Concrete Appliances Co. and Wm. H. Insley against John E. Gomery and others.

The patents involved apparatus for



PANORAMA OF SHOW TENTS AT ALL-WESTERN ROAD SHOW. PART OF "PROVING GROUND" IN FOREGROUND AND GOLDEN GATE IN DISTANCE

distributing wet concrete in construction work, whereby the concrete is raised to a hopper and thence distributed through a movable chute.

In a case before the Sixth Circuit Court of Appeals, the patents were declared valid. In another case, the Third Circuit Court of Appeals held them invalid as lacking inventive genius.

Justice Stone, for the Supreme Court, said that certain evidence apparently did not go before the Sixth Circuit Court and that the decision of the Third Circuit Court was correct. The decision asserts that the underlying principles of the patents have been known and used for centuries, and that similar means of distribution are common in grain elevators and in handling ore and coal. The application of these principles to the distribution of wet concrete, the court held, is merely the product of ordinary mechanical skill, and that a combination of simple and known principles does not constitute inventive genius; hence there was no infringement of the patents.

Concrete Road Yardage

For October the square yardages included in concrete pavement contract awards, according to the Portland Cement Association, were: 3,710,836 for roads; 2,163,903 for streets; and 260,642 for alleys; or a total for the month of 6,135,381 sq.yd.

The accompanying table summarizes the statistics for the current year:

SQUARE YARDS OF CONCRETE PAVEMENT AWARDED DURING 1925

Month	Roads	Streets	Alleys	Total All Classes
Jan.....	3,474,421	963,256	75,236	4,512,913
Feb.....	3,787,192	1,201,224	58,723	5,047,139
March..	5,728,862	2,483,662	190,553	8,403,077
April...	12,462,646	4,431,220	469,117	17,362,983
May....	7,724,075	4,169,707	392,656	12,286,438
June....	5,980,857	3,904,733	335,981	10,221,571
July....	6,361,686	5,147,203	535,156	12,044,045
Aug....	6,368,201	2,973,301	252,341	9,593,843
Sept....	4,087,442	5,018,902	624,006	9,730,350
Oct.....	3,710,836	2,163,903	260,642	6,135,381
Totals	59,686,218	32,457,111	3,194,411	95,337,740

Paradon Co. Declared Infringer of Chlorinator Patent

The United States Court for the Eastern District of New York decreed on Nov. 10 that the Paradon Engineering Co., Inc., New York City, has infringed the Georg Ornstein patent on the solution feed process for the chlorination of water and sewage.

The patent was numbered 1,142,361, dated June 8, 1915, and assigned to the Electro Bleaching Gas Co., which subsequently made the Wallace & Tiernan Co., Newark, N. J., sole licensee. The two companies just named were joint plaintiffs in the suit. The defendant alleged invalidity and non-infringement. The district judge, D. J. Campbell, in a lengthy opinion, reviews all the patents and other evidence cited to show invalidity, rules out each one and declares the process used in the Paradon apparatus a clear case of infringement on the Ornstein patent. The judge declares "that the defendant has appropriated all the advantages of the [Ornstein] invention" and that "infringement cannot be avoided merely by changes in the form of the defendant's apparatus from the absorption tower to the injector."

Complaint Dismissed

The complaint of the Federal Trade Commission filed in September, 1924 against the Permutit Co., New York City charging it with unfair trade practices was unqualifiedly dismissed on Oct. 20 after an exhaustive investigation. The company is thus vindicated of any charge of unfair trade practice. The Permutit Co. manufactures and sells zeolite water softeners and other appliances for general sanitation purposes.

Business Notes

AMERICAN VIBROLITHIC CORP., Des Moines, Iowa, announces the appointment of Norman D. Dean to vice-president in charge of operations. Col. Dean's duties will be directly associated with the sale, construction and technical aspects of vibrolithic pavements and interlocking bases for bituminous pavements. Colonel Dean has had many years of experience in foreign and domestic affairs in the Corps of Engineers, U. S. Army. As a consulting and constructing engineer in civil capacities, he has been engaged in engineering works in the United States and many foreign countries. This new department of operations will be located at the general offices in Des Moines, Iowa.

PHILIP A. LANG, London, England, special European representative of Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., and for many years works manager of the company's plant at East Pittsburgh, is in the United States consulting with officials of the company. Mr. Lang's primary purpose in his present trip to America is to gain first-hand information of the engineering trend of the country as influencing the activities of his company. Mr. Lang has been associated with the Westinghouse company since its beginning in 1886.

WILLIAM G. CLYDE has recently been elected president of the Carnegie Steel Co., Pittsburgh, Pa. Mr. Clyde has had many years of experience in the mills and sales departments of numerous steel companies, coming into his present position after being vice-president and general manager of sales of the Carnegie Steel Co. since 1918.

PITTSBURGH-DES MOINES STEEL CO., Pittsburgh, Pa., announces the opening of a new sales office in the Masonic Building, South Jacksonville, Fla., to be in charge of John E. Jackson, recently of the company's Richmond office. The new office will handle all sales in the state of Florida.

OIL JACK CO. INC., New York City, announces the appointment of Fred D. Sweet as manager of its middle western territory with offices in the Wrigley building, Chicago.

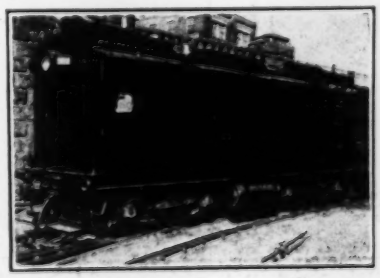
KANSAS CITY BOLT AND NUT CO. recently transferred the controlling interest in the company to W. L. Allen, and a new corporation known as the Sheffield Steel Corp. has been formed with Mr. Allen as president. The new corporation has taken its name as being more nearly representative of the company's major products. Until a few years ago over 90 per cent of the company's output was bolts and nuts. Today, although there has been a steady increase in this branch of the business, it represents less than 25 percent of the total tonnage produced. The officers of the new company are as follows: R. L. Gray vice-president; L. L. Middleton, secretary; H. R. Warren, treasurer; Ernest Baxter, general manager of sales; and J. C. Shepherd and J. W. Anderson, assistant general managers of sales.

SILENT HOIST CO., Brooklyn, N. Y., announces the appointment of the following distributors as exclusive sales agents for its winches, cranes and derricks: Standard Auto Body Works, 1501 Central Ave., Los Angeles, Calif.; Trailer & Truck Equipment Company, 1340 Howard St., San Francisco, Calif.; and the McKenna Company, 38th St. and Perkins Ave., Cleveland, Ohio.

Equipment and Materials

Railroads Purchase Oil-Electric Locomotives for Switching Work

The Central Railroad of New Jersey has recently purchased a 60-ton oil-electric locomotive for switching service in its Bronx terminal, New York City. The Long Island Railroad Co. has also purchased a 100-ton type, also for use in switching in its metropolitan yard. These two slow-speed types of



60 and 100 tons are capable of developing respectively 300 hp. and 600 hp. The smaller has a maximum speed of 30 miles per hour and exerts a tractive effort of 36,000 lb. The larger unit

can make the same maximum speed and develop a tractive effort of 60,000 lb.

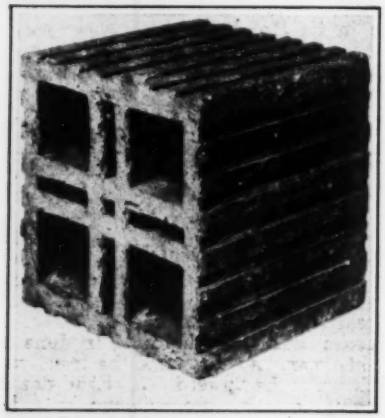
Designs have also been developed for two road types. A 60-ton road locomotive will have a tractive effort of 23,000 lb., develop 300 hp. and have a maximum speed of 45 m.p.h. The larger type will weigh 85 tons and have a tractive effort of 50,000 lb., develop 600 hp. and have a maximum speed of 55 m.p.h.

The illustration shows the 60-ton switching locomotive of the Central Railroad of New Jersey. It is the joint product of the American Locomotive Co., the General Electric Co., and the Ingersoll-Rand Co. The oil engine has six cylinders and is of the 4-cycle, single-acting, vertical type. The forced feed system of lubrication is used and functions through a gear-driven pump in the crank case. To start the engine, compressed air at a pressure of 200 lb. is admitted successively to each cylinder through mechanically operated starting valves. Two small compressors furnish a continuous supply of starting air.

The direct-connected generator has a voltage range of 200 to 750 and the output is regulated by a throttle according to the demands made upon the dynamo by the tractive motors. The engineer controls the locomotive by two control handles. One serves as a throttle lever to control the output of the engine, while the other is a master controller or electric switch which puts the tractive motors either in series or in parallel as circumstances may require.

Double-Web Hollow Tile Blocks Interchangeable With Brick

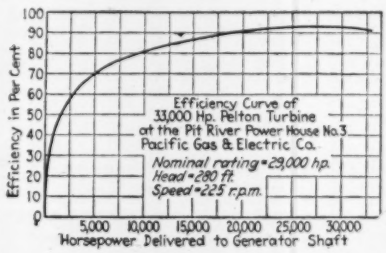
A hollow tile block of exceptionally sturdy construction whose measurements coincide with established brickwork, in which a brick is the unit of measure, is manufactured by Heath Cube Service, Inc., 310 West Broad St., Columbus, Ohio, and known as the Heath cube. Only two shapes and sizes are provided, an 8x8x8-in. cube weighing 18 lb., and a 4x8x8-in. half cube



weighing 9 lb. One cube equals exactly 6 brick in volume and thus any thickness and any detail of wall designed in brick sizes can be built with these cubes. The double cross webs of the block add to its rigidity and are of the same thickness as the outer shells which detail is claimed to result in uniform shrinkage of the structure when any occurs. These cubes are laid in a "pyramidal" bond in which each cube is laid directly over the cross joints of the course below, thus overlapping a half of their width in both cross-wise and length-wise directions. This property of a constant and fixed alignment of the double webs over two shells insures maximum strength and is claimed to eliminate all shear stresses. The webs and shells are ⅝ in. thick and the cube contains 52 per cent solids and 48 per cent voids. The weight of 1 cu.ft. of this masonry including the mortar is 63 lb.

Impulse Wheel Shows Efficiency of 93 Per Cent

In the recently conducted tests on the Pelton water wheels in the Pit River No. 3 plant of the Pacific Gas & Electric Co. in northern California, the

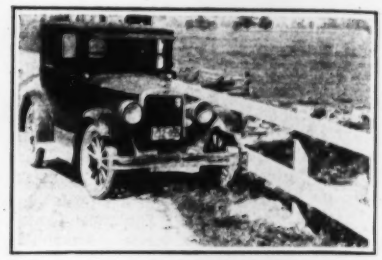


very satisfactory efficiency of 93 per cent was certified to by representatives of power company, manufacturer and the independent engineer retained to test the units by the salt velocity method.

Unit No. 1 showed efficiencies over 90 per cent from 18,880 hp. to full gate opening, more than 92 per cent from 22,500 hp. to 31,650 hp. and a maximum efficiency of 93 per cent at about 27,500 hp. The unit has a nominal rating of 29,000 hp. and was kept under the normal head of 280 ft. during the test.

Steel Highway Guard Rail Made of Specially Rolled Shape

A new steel guard rail known as the "life-saver," manufactured by the Galion All-steel Body Co., Galion, Ohio, consists of two rails of special steel sections, which provide that when the structure is erected the part exposed to the highway is perfectly smooth. The rails are claimed to be held in perfect alignment at the joint by means of a mechanical device that not only prevents separation but also makes the necessary allowance for expansion and contraction. The posts are of special U-shape construction and are furnished in either 10 or 12-gage metal. The lower rail is so placed that only the bumper, tire and rub of the car will strike it, and the smooth surface of this rail is claimed to bring the machine back into the road when a car hits it at an angle. This rail unit is guaran-



teed for 25 years, and both guard rails and posts are painted an illuminating white. It is claimed that the cost is approximately the same as that of a good wooden guard rail.

Publications from the Construction Industry

Centrifugal Pumps — DE LAVAL STEAM TURBINE CO., Trenton, N. J., features its complete line of single- and multi-stage centrifugal pumps in a new 72-p. catalog. Considerably more than half of the catalog is devoted to a discussion of the design and applications of centrifugal pumps, a special section being devoted to their use in water-works pumping plants. Special attention is given to such major details as speed-reducing gears, motor drives, steam turbine drives, and belt and rope drives. Several pages are devoted to manufacturing methods and materials, together with a description of the factory tests to which the pumps are subjected. A page is devoted to a listing of the information required to accompany inquiries. Pump characteristic curves and hydraulic tables and formulas complete the booklet.

Electric Industrial Trucks—CRESCENT TRUCK CO., Lebanon, devotes a new catalog of 40 pp. to descriptions and illustrations of its line of electric industrial trucks and tractors for use principally in industrial plants and construction warehouses. Many illustrations are given of the trucks in use and the different models, including the elevating platform trucks, are described.

Portable Conveyors—GEO. HAISS MFG. CO., New York City, features its portable belt conveyors in a new booklet just issued. General specifications for its hand-propelled, wheel-mounted belt conveyors, both trough belt and flat belt type, are given. In addition to this, tables of standard sizes and rated carrying capacities are shown, together with several typical installation layouts.

Roofing—HOLORIB, INC., Cleveland, Ohio, is distributing a catalog describing its new insulated roofing system, consisting of a steel supporting member, covered with an insulating material over which is applied a built-up bituminous waterproofing. The booklet describes the system and gives illustrations of a number of buildings upon which it is used or being placed.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

This Week's Contracts—Week Ago—Same Week Last Year

THE money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks. Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial buildings.

Money Value of Contracts Let—Entire U. S.

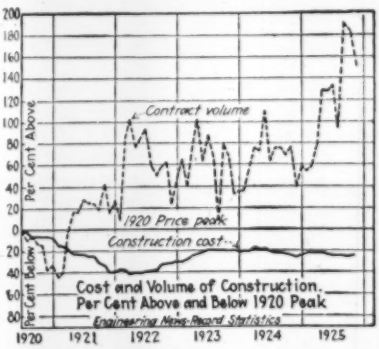
Week Ending	Public Work	Private Work	Total Contracts
November 19, 1925	$12,327,000	$31,523,000	$43,850,000
November 12, 1925	13,866,000	35,810,000	49,676,000
November 20, 1924	10,212,000	25,429,000	35,641,000
Heaviest Week			
1925, Sept. 3	16,215,000	69,424,000	85,639,000
1924, May 8	26,370,000	38,829,000	65,199,000
January 1 to Date			
1925	948,522,000	1,324,608,000	2,273,130,000
1924	900,962,000	938,088,000	1,839,050,000

Record Construction Volume—Unprecedented Bank Debits

These and Other Indicators Show High Rate of Speed at Which Business Is Traveling—Easy Credit May Spell Inflation

THIS year will not only break all previous records in money value of construction contracts let but August, September and October, 1925 will also stand out as record months in actual volume of work accomplished.

Compared with the peak of the 1920 inflationary period, construction cost is 25 per cent below and volume 153 per



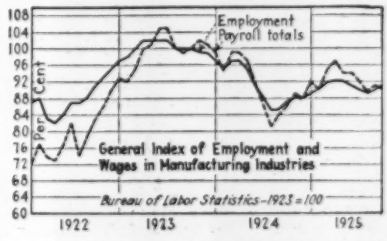
cent above June of that year, according to *Engineering News-Record* statistics.

While building materials constitute a very large part of the present record movement of revenue freight, the marked gain, compared with the past two years, in less-than-carlot loadings indicates sustained activity in the lesser industries.

The recent abrupt drop in stock prices, due to excessive speculation, together with the anthracite coal miners' strike, have evidently had little effect upon the steady increase in volume of general business.

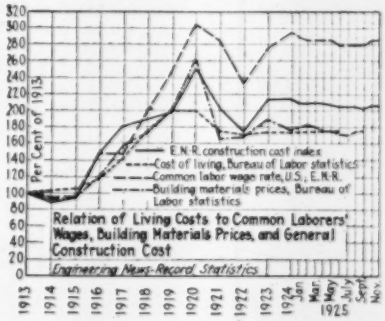
According to the U. S. Department of Labor, strikes and labor troubles, generally, have been on the down-trend since the latter part of 1923. There is no notable disturbance anywhere in the building trades at the present time.

Latest reports of the Bureau of Labor Statistics show an increase in mill and factory employment accompanied by a slight decline in total payrolls. There has, however, been no decline in the average wage rate of unskilled workers in construction operations since June of this year. The gain in employment affected all sections of the



country except parts of New England.

The recent gain in bank debits or payments by check, shows the increasingly great turnover of money in the markets of the nation. These payments are for services rendered or goods received and while the element of inflation may be present, due to easy credit conditions, these reports from the Federal Reserve districts indicate the substantial volume of business actually transacted. October bank debits for the nation, totaled $52,929,830, the heaviest month on record.



The recovery of wholesale prices during the past month included nearly all commodities; foodstuffs were among the few exceptions. Latest reports on cost of living, issued by the Bureau of Labor Statistics, appeared in June of this year. At that time the trend was shown to be upward. A slight rise in living costs in July, followed by a declining tendency from July to September, is shown by the National Industrial Conference Board's computation of the purchasing value of the dollar (based on 1914 as $1) as follows: June, 59.9c.; July, 59.3c.; September, 59.4c.

A Pamphlet for Your Answer

Engineering News-Record invites answers to two questions:

1. *Are construction volume statistics of any use to you?*
2. *If so, in what way do you use them?*

One man in our home office gives his entire time to compiling the number and value of contracts awarded each week and each month in the various branches of engineering in the principal sections of the country. We want to know if these figures are of real, specific value to our readers, and if so—just how.

If you will be so good as to tell us about this, we will acknowledge your letter by sending you free of charge a reprint called "Civil Engineering and Construction During 1924" AND, incidentally, you will be placed on the list for notification immediately our booklet, "Engineering News-Record Construction Costs," is ready for distribution.

QUESTIONS

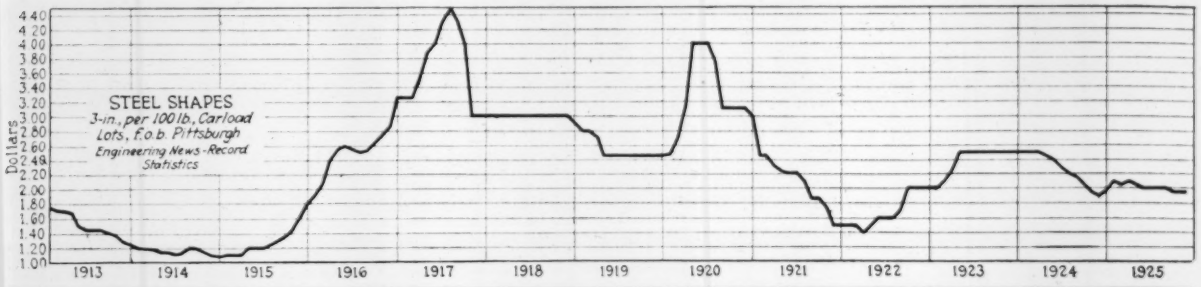
1. *Are construction volume statistics of any use to YOU?*
2. *If so—just how do you use them?*

A reprint of costs for your answer.

CONSTRUCTION NEWS EDITOR,
Engineering News-Record,
Tenth Avenue at 36th Street, New York

Weekly Construction Market

STEEL is possibly the most important item in the current market for construction materials. There is a slight show of firmness in brick and cement in New York, while c.-i. pipe and linseed oil are down in Atlanta and hollow tile, in Denver. The Pittsburgh mill price of steel shapes has hovered about the $2 per 100-lb. mark since the beginning of the current year. The price now is $2 per 100 lb. for single carloads and $1.90 for larger tonnages. Present heavy output and demand may force an upturn in the price curve shortly. There is little buying for replenishment of stocks in the basic materials and production capacities are very great.



	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb.	$3.34	$3.90	$4.00	$3.10	$3.35	$3.07½	$3.30	3.35	$4.25
Structural rivets, 100 lb.	4.50	4.45	4.75	3.50	3.75	4.65	5.00	3.75	6.00
Reinforcing bars, ¾ in. up, 100 lb.	3.24	3.40	3.38	3.00	3.25	3.77½	3.35	3.25	2.30
Steel pipe, black, 3½ to 6 in. lap, discount	48%	55%	53.6%	51%	54.25%	36%	39.2@51%	50%	59.49
Cast-iron pipe, 6 in. and over, ton	50.60@51.60	—48.00	54.00	49.20@50.20	53.00	63.00	53.00	55.00	55.00
Concreting Material									
Cement without bags, bbl.	+2.50@2.70	2.25	2.05	2.10	2.32	2.84	2.31	2.65	1.80
Gravel, ¾ in., cu.yd.	1.75	2.20	2.38	2.00@2.20	1.65	1.90	2.15	1.50	1.25
Sand, cu.yd.	1.00	1.65	2.00	2.00@2.20	1.25	1.00	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.85	2.20	2.83	2.00@2.20	1.75	2.50	2.15	3.00	1.90
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	61.00	34.00	60.00	54.50	35.75	33.75	27.00	25.00	60.00
Lime, finishing, hydrated, ton	18.20	22.50	20.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime, common, lump, per bbl	2.25@2.75	1.30	1.85	1.30	1.35	2.70	1.60	2.80	9.50
Common brick, delivered, 1,000	+17.50@19.50	10.50	11.10	12.00	13.50	12.00	15.50	15.00	17.50
Hollow building tile, 4x12x12, per block	Not used	.0893	.10	.075	.....	.075	.....	.10	.12
Hollow partition tile 4x12x12, per block	.1027	.0893	.10	.075	.07	.075	.108	.10	10
Linseed oil, raw, 5 bbl. lots, gal.	1.02	—1.07¼	1.13	1.01	1.11	1.23	1.11	1.12	1.25
Common Labor									
Common labor, union, hour	.55@.75	.30	.....	.87½	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	.....	.25	.30@.50	.82½	.45@.55	.35@.50	.50	.50	.25@.35

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Labor—Concrete laborers' rate, 93¾c.; building laborers, 75c.; excavating laborers, 55c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone delivered on job; pine is 4-in. instead of 3-in.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.60 for Sheboygan. Common labor not organized.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of November 5, the next on December 3.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on pine lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 100.093). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 3½-in., $59.49.

Business Briefs

Call money: 5 per cent, Nov. 17; year ago, 2½ per cent.

Time loans: 60@90 days, 4¾@5 per cent; longer periods, 5.

Commercial paper: Best names, 4½ per cent; others, 4¾.

On November 1, 1925

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For Explanation and Details of Indexes Since 1913 See the First Issue of Every Month